

NUCLEOPHILIC DISPLACEMENTS ON ESTERS IN MOLTEN THIOCYANATE SALTS<sup>1</sup>

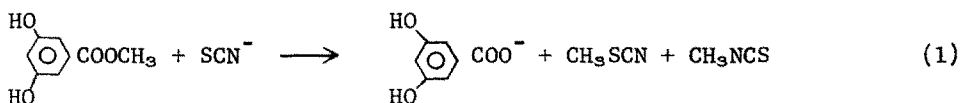
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(Received in USA 26 January 1970; received in UK for publication 17 February 1970)

Nucleophiles typically add to unhindered carboxylic esters at the carbonyl group. SN2 reactions at the saturated carbon of the alkoxy group are observed only when the corresponding alkoxide ion is used as the nucleophile<sup>2</sup> or when the nucleophile has no affinity for the sp<sup>2</sup> carbon of the carbonyl group. The very few examples of the latter case include the cleavage of simple methyl esters by trimethylamine<sup>3</sup> and by lithium halides in pyridine<sup>4a</sup> or 2,4,6-collidine.<sup>4b</sup>

Neither thiocyanate nor the more powerful nucleophile, thiosulfate ion, reacts with esters in aqueous solution at room temperature. Fused KSCN-NaSCN,<sup>5</sup> however, provides a greater nucleophile concentration at higher temperature in an aprotic, ionic solvent. We have found that methyl 3,5-dihydroxybenzoate, like many polyhydroxy compounds,<sup>6</sup> is soluble in this medium and gives a 75% yield of methyl thiocyanate together with 6% isothiocyanate.



Evidence for an SN2 mechanism is provided by the kinetics, followed by weighing the products vaporizing from the hot, non-volatile salt into a vacuum system. Because the reaction is first order in ester, there is no catalysis by the phenolic hydroxyl groups. The ethyl ester reacts only 1/50 as rapidly as the methyl at 150° and produces no ethylene, a product which would have indicated ester pyrolysis or other mechanisms involving alkyl-oxygen cleavage

prior to nucleophilic attack. The proportion of iso product from the ethyl ester is about 50%.

Methyl 2,4-dihydroxybenzoate reacts similarly, but with decarboxylation of the 2,4-dihydroxybenzoate ion to resorcinol. This converts one mole of ester to an unreactive phenoxide ion for each mole which reacts (eq 2) and explains the observed first-order approach to a 50% yield of CO<sub>2</sub>. The rate,  $2 \text{ HO} \text{---} \text{C}_6\text{H}_3 \text{---} \text{COOCH}_3 + \text{SCN}^- \longrightarrow \text{HO} \text{---} \text{C}_6\text{H}_3 \text{---} \text{OH} \uparrow + \text{CO}_2 + \text{CH}_3\text{SCN} + \text{CH}_3\text{NCS} + \text{HO} \text{---} \text{C}_6\text{H}_3 \text{---} \text{COOCH}_3^-$  (2) which can be measured by the volume of CO<sub>2</sub> produced as well as by product weight, is slightly less than that of the 3,5 ester. There is therefore no evidence of intramolecular catalysis by the neighboring hydroxyl group. Furthermore there is no driving force due to decarboxylation, which must not occur simultaneously with displacement. (Decarboxylation of potassium 2,4-dihydroxybenzoate was shown to be rapid in the fused salt at 150°.) However the activation energy for methyl 2,4-dihydroxybenzoate is a few kcal/mole lower than for the 3,5 ester.

<u>ester</u>	<u>k(150° C.)</u>	<u>ΔH<sup>‡</sup></u>
3,5 methyl	3.2 X 10 <sup>-4</sup> sec <sup>-1</sup>	26 kcal/mole
3,5 ethyl	6.5 X 10 <sup>-6</sup>	---
2,4 methyl	9.3 X 10 <sup>-5</sup>	22

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