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EXAMINATION OF THE RING-CHAIN ISOMERISM OF 2-HYDROXY-CHROMANONES WITH ^{1}H NMR SPECTROSCOPY

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Summary. In the cyclic derivatives (1) the hydroxyl group is of pseudo-axial orientation (1: α-anomer) and no equatorial form (1: β-anomer) has been detected. The ring-opened compound exits in keto-enol equilibrium (2 ⇌ 3) dependent of the R-substituent.

The preparation of 2-hydroxychromanones from 2-hydroxyacetophenone by Claisen condensation has been reported and the product has been declared[1] as ω-formylacetophenone (2a) of β-diketo structure. In previous papers several authors suggested[2] this chainform but others took a stand on the cyclic structure[3] such as in the case of the 2-trifluoromethyl derivatives[4]. In a recent paper the ring-cleavage process of 2-carbethoxy-2-hydroxy--chromanone was described[5].

In a previous paper[6] we have investigated the structure of 2-hydroxy-chromanones substituted at the aromatic ring and at C-3. These compounds were confirmed as cyclic derivatives bearing pseudo-axially oriented hydroxyl function at low temperature (0- -40 °C).

In the present communication we report on the stereochemistry of analogues substituted at the aromatic ring but no substituent at C-3 (1a-1g) and the phenomenon of the opening of the cyclic structure.

When a solution of 2-hydroxychromanone (1a) in $CDCl_3$ was investigated immediately after dissolution spectral band characteristic of the cyclic structure could be assigned at room temperature, as well. The H-3 atoms are nonequivalent (A and B protons) and are in coupling both with H-2 and C_2-OH. As shown by the coupling constants (summarized in Table 1 : $J_{3a',3e'}=J_{AB}$; $J_{3a',2e'} = J_{AX}$; $J_{3e',2e'} = J_{BX}$; $J_{3a',OH} = {}^4J_{H,OH}$) the C_2-OH group is pseudo - axially oriented. No pseudo-axial H-2 atom was observed indicately that the β-anomer (7) was not produced.

The heterocyclic ring is depicted in the so-called "sofa" conformation as suggested by Philbin and Wheeler[7].

When the solution of 1a was investigated after 20 minutes novel bands, assignable to the ring-opened 2a were observed in the spectrum. The chemical shifts δ=4.07 d , δ=9.95 t and δ=11.88 s could be assigned to the methylene group, the aldehyde proton and to the phenolic OH group being in hydrogen bonding, respectively.

After standing for a longer period forms 2 are enolized and novel bands characteristic of structure 3 could be observed. In the case of 3a

the shift δ=6.23 d could be assigned to H_α whereas the shift δ=12.09 s and δ=13.9 s corresponded to the phenolic and enolic hydroxyl group, respectively (see Fig.1.).

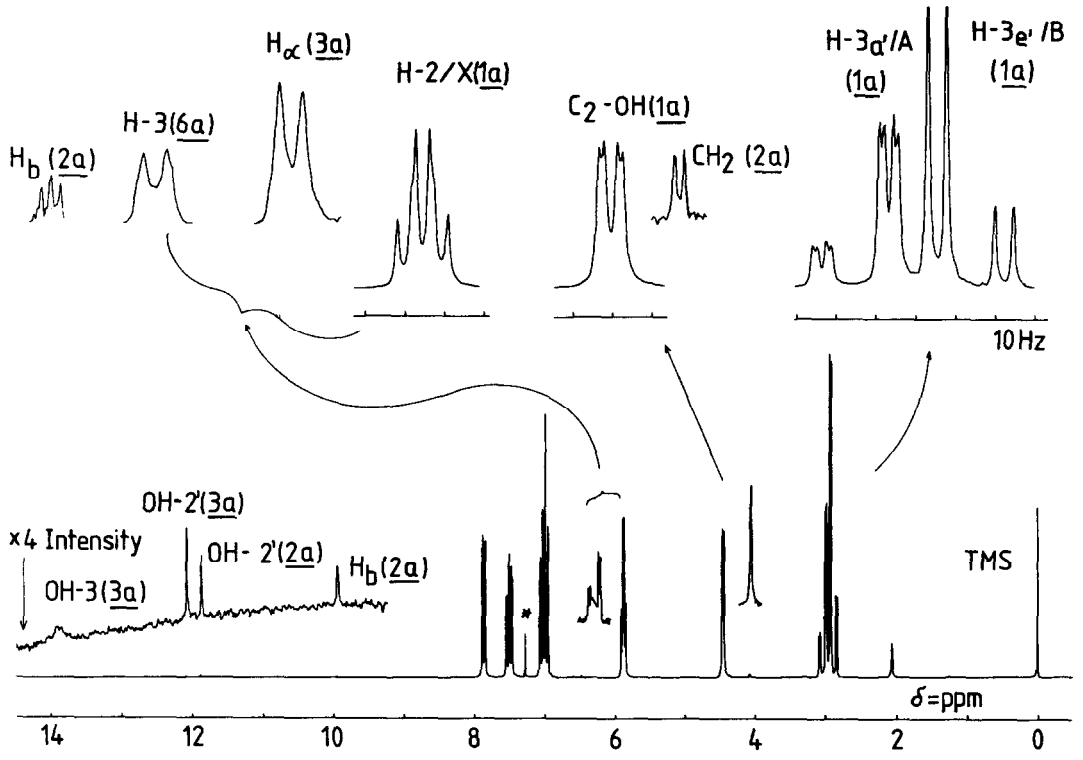


Fig.1. ^1H NMR spectrum of 1a in $CDCl_3$ after dissolving with 2 hrs

The formation of the other possible enolic form (4) was not observed.

Starting from pure 1 an additional dehydration process resulting in the chromone derivative (6) always proceeds in solution. Thus the formation of this compound may be accomplished, for example in chloroform, by two alternatives:

(i) the opening of the ring can proceed by an initial dissociation of the C_2-OH - as described[8] for example in the case of hexoses - followed by the formation of the chromone derivative (6) via intramolecular transformation of the enol forms (3) or (5) of the resulting β-dicarbonyl derivative: 1 ⇌ 8 ⇌ 2 ⇌ 3 ⇌ 5 → 6 .

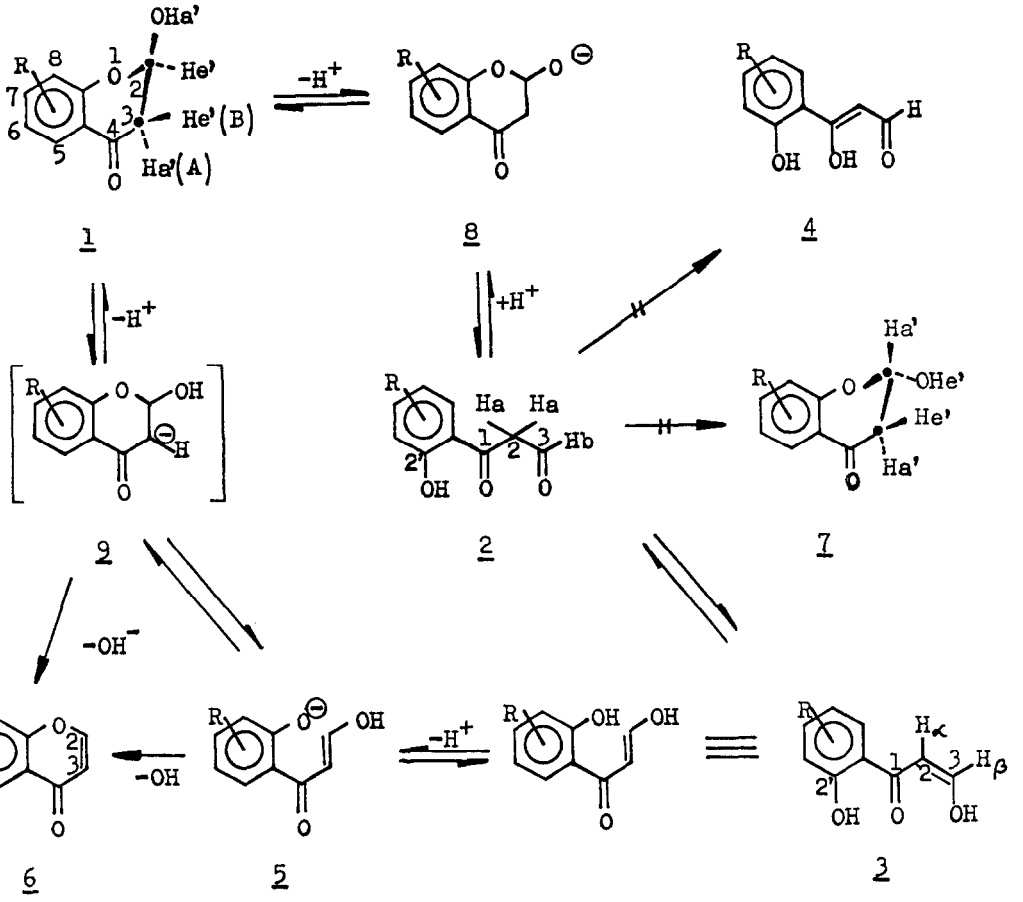
(ii) the chromone forms from the cyclic compound via carbanion 9, as supposed earlier in the case of 2-hydroxyisoflavanones[9]: 1 ⇌ 9 (⇌ 5) → 6 (see Scheme 1.).

According to our NMR measurements it is supposed that the establishment of the conversion by alternatives (i) and (ii) is dependent on the nature of the R substituent and in the case of a given compound the two

pathways may be even simultaneously effective.

In the case of electron donor R substituent the enolization of the resulting ß-diketo form (2) is slow. With electron withdrawing group the concentration of 2 is low, it is stabilized in the enol form (3), and also, the rate of conversion into chromone (6) is increased.

The contribution of the acyclic form does not exceed 3-28 %, and instead, the formation of chromone - being the most stable in the system - is observed and finally this latter compound appears as the exclusive product.



a : R=H

b : R=7-OCH_3

c : R=7-Cl

d : R=7-NO_2

e : R=6-OCH_3

f : R=6-Cl

g : R=6-NO_2

Scheme 1.

Table 1. ^{1}H NMR data of 1,2 and 3 compounds[x,y]

Compound	Chemical shifts (δ=ppm) H-2 or H-b	H-3	or H-α/a	Coupling constant (J=Hz) J_{AB}	J_{AX}	J_{BX}	$J^{\alpha,\beta^{o}}_{a,b^{u}}$	mol percent 1^h	200^h
1a	5.88m	3.01m	2.89m	16.8	4.1	4.0		90	89
2a	9.95t		4.07d				2.6	7	2
3a			6.23d				6.2	3	9
1b	5.86m	2.99m	2.84m	16.6	5.1	3.2		85	85
2b	9.90t		3.99d				2.5	2	1
3b			6.10d				5.8	13	14
1c	5.92m	3.01m	2.90m	16.8	4.3	3.5		85	85
2c	9.95t		4.05d				2.6	2	1
3c			6.17d				5.9	13	14
1d	6.00m	3.10m	3.00m	17.0	3.7	3.4		90	80
3d			6.25d				4.2	10	20
1e	5.85m	3.01m	2.88m	16.9	4.8	3.3		98	97
3e			6.18d				5.8	2	3
1f	6.10m	3.21m	3.09m	16.9	4.5	3.1		93	85
3f			6.30d				5.6	7	15
1g	6.08m	3.09m	3.01m	16.8	3.8	3.2		90	72
3g			6.35d				5.8	10	28

x: Solvent: $CDCl_3$; y:2d,2e,2f and 2g undetectable because of fast enolization; o: in enolic form; u: in β-diketo forms; d: doublet; t: triplet; m: multiplet

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