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α/β-Selectivity in Hydrolyses of α- or β- Naphthyl Acetates in the Presence of Cycloamyloses.

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Cyclohexaamylose hydrolyzed α-naphthyl acetates more rapidly than the corresponding β-isomers, a phenomenon termed "α-selectivity", while cyclooctaamylose showed "β-selectivity" and the selectivity of cycloheptaamylose fell between those of cyclohexa- and cycloocta-amyloses.

On the hydrolyses of substituted phenyl acetates by cyclohexaamylose or cycloheptaamylose, meta-substituted phenyl esters were more rapidly hydrolyzed than the corresponding para-isomers, a phenomenon termed "meta-selectivity"[1]. This selectivity is attributed to the structure of the inclusion complex[1]. Therefore, in the case of the hydrolysis of the substrate which has more than two structures of productive inclusion-complexing, the selectivity is expected to depend on the cavity size of the cycloamylose.

In this paper, we wish to demonstrate "α/β-selectivity" in hydrolyses of α- or β-naphthyl acetates (**1**a~c and **2**c,d) by cyclohexa-, cyclohepta-, and cycloocta-amyloses[2]. The hydrolyses (pH 10.60) of α- and β-naphthyl acetates (**1**a,b) were measured spectroscopically at 25°C in the presence of an excess of cycloamyloses and showed pseudo-first-order kinetics. From Eadie treatment[3] of the kinetic data, the Michaelis constants (Km) and the maximum catalytic rate constants (k_c) were obtained (Table I and Scheme I). Cyclohexaamylose had an α-selectivity while cyclooctaamylose showed a β-selectivity. The selectivity of cycloheptaamylose fell between those of cyclohexa- and cyclooctaamyloses, showing a slight α-selectivity. This selectivity variation seems to be due to the structural change of the inclusion complex depending on the cavity size of the cycloamylose. Cyclohexaamylose of the smallest cavity size would bind the substrates predominantly as shown in **3** and **4**, whereas the

Table I. Maximum Catalytic Rate Constants (k_c) and Michaelis Constants (Km) for Reactions of Cycloamyloses with α- and β-Naphthyl Acetates[a,b].

Cycloamylose	k_c (x 10^{-2} s^{-1})		Km (x 10^{-2} M)		Selectivity k_c/Km ($s^{-1}M^{-1}$)	
	1a	1b	1a	1b	1a	1b
cyclohexaamylose	4.3	0.45	6.9	2.0	0.63 (α-selectivity)	0.22
cycloheptaamylose	5.0	0.58	0.90	0.14	5.5 (no selectivity)	4.2
cyclooctaamylose	0.85	2.7	0.85	0.98	1.0 (β-selectivity)	2.8

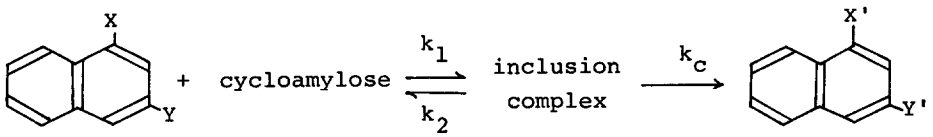
[a] In carbonate buffer (pH 10.60, I=0.075), 25°C, with 0.50-0.70% (v/v) CH_3CN added.

[b] Uncatalyzed rate constant : 0.065 x 10^{-2} s^{-1} for 1a, 0.055 x 10^{-2} s^{-1} for 1b.

Table II. Yields of Products for Reactions of Cycloamyloses with 1,3-Diacetoxynaphthalenes[a].

Cycloamylose	Yields of Products (%)		
	2c	2d	2e
cyclohexaamylose (0.15 M)	60.3	17.8	1.3
cyclooctaamylose (0.18 M)	14.1	37.3	10.1
none	12.9	12.9	0.4

[a] At pH 10.60, 25°C. Reaction period : 30 sec. Nearly saturated cycloamylose solution was used.



1a X=OAc Y=H
1b X=H Y=OAc
1c X=OAc Y=OAc

2a X'=OH Y'=H
2b X'=H Y'=OH
2c X'=OH Y'=OAc
2d X'=OAc Y'=OH
2e X'=OH Y'=OH

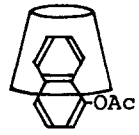
Scheme I

Table III. Hydrolysis Rate Constants of Hydroxy-acetoxy-naphthalene in the Presence or Absence of Cycloamylose[a,b].

Cycloamylose	k_{obs} (x 10^{-3} s^{-1})	
	2c	**2d**
none	0.26	0.26
cyclohexaamylose (0.15 M)	2.2	5.8
cyclooctaamylose (0.18 M)	16	2.8

[a] Appearance of 1,3-dihydroxynaphthalene (**2e**) and disappearance of the hydroxy-ester (**2c** or **2d**) were followed by HPLC. The rate constant, k_{obs}, was estimated from the half-life method.

[b] Carbonate buffer, pH 10.60, I=0.15, 25°C.



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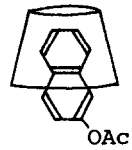

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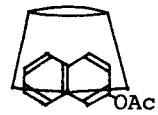

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better-fit binding structures of cyclooctaamylose would be **5** and **6**. Acetyl groups in **3** and **5** are closer to an active secondary hydroxyl group of the cycloamylose than those in **4** and **6**, respectively. This proximity of the acetyl group to the active hydroxyl can explain the selectivities described above. Since the both type of binding structure would be possible for cycloheptaamylose, the selectivity is expected to be obscure. This coincides with the experimental result.

On the basis of the above discussion, it may be possible to hydrolyze an ester group of a di-ester or a higher ester selectively. To test this possibility, the hydrolysis of 1,3-diacetoxynaphthalene (**1c**) was carried out. The products (**2c~e**) were analyzed by means of HPLC. The hydrolysis of **1c** without the cycloamylose gave **2c** and **2d** in equal amount. The presence of an excess of cycloamyloses brought about the selectivity and the rate enhancement (Table II). As shown in Table II, **2c** or **2d** was mainly obtained in the presence of cyclohexaamylose or cyclooctaamylose, respectively[4]. Although the uncatalyzed hydrolysis rate of **2c** was the same as that of **2d**, the latter was also hydrolyzed more rapidly than the former in the presence of cyclohexaamylose (Table III). Cyclooctaamylose again showed the reverse selectivity in the hydrolyses of **2c** and **2d**. These results are similar to the kinetic results of **1a** and **1b**.

Thus, this report is the first description about the reversion of reaction selectivity by the cavity size of the cycloamyloses[5].

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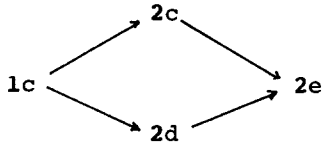
REFERENCES AND NOTES

(1) R. L. VanEtten, J. F. Sebastian, G. A. Clowes, and M. L. Bender, J. Am. Chem. Soc., 89, 3242 (1967).

(2) Hydrolyses of β-naphthyl acetate by cyclohepta- or cycloocta-amyloses under different conditions (pH 9.0 in 0.05 M Tris buffer or pH 8.3 in 0.02 M Tris buffer, respectively, at 1 bar) from the present one were reported. Y. Taniguchi, S. Makimoto, and K. Suzuki, J. Phys. Chem., 85, 3469 (1981). In this report, Km values for cyclohepta- or cycloocta-amyloses were 0.102×10^{-2} M or 0.98×10^{-2} M, respectively, and k_c values were 0.0558×10^{-2} s^{-1} or 0.049×10^{-2} s^{-1}, respectively.

(3) G. S. Eadie, J. Biol. Chem., 146, 85 (1942).

(4) By the computer treatment of the data shown in Table II and Table III according to Scheme II, the formation rate constants of **2c** and **2d** from **1c** were estimated to be 0.088 and 0.024 s^{-1}, respectively, in the presence of cyclohexaamylose, or to be 0.075 and 0.142 s^{-1}, respectively, in the presence of cyclooctaamylose.



Scheme II

(5) The reversion of the reaction selectivity of cycloheptaamylose by its simple modification on the primary hydroxyl side has been reported by us. K. Fujita, A. Shinoda, and T. Imoto, J. Am. Chem. Soc., 102, 1161 (1980). Tetrahedron Lett., 1541 (1980).

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