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Chemistry of Succinimido Esters. VIII*¹.Kinetic Studies on the *N*-Arylcarbonylation of Aliphatic Primary Amines by *N*-Succinimidyl Benzoates in Aqueous Solution

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The reactions of *N*-succinimidyl benzoates (1) with aliphatic primary amines (2) (RNH_2 ; R = *n*-Pr, *iso*-Pr, *n*-Bu, *s*-Bu, *t*-Bu, and *n*-Am) were studied kinetically at 25°C in aqueous solution ($7.0 \leq \text{pH} \leq 10.5$). *N*-arylcarbonylation was competitive with the decomposition of (1) and the rate is expressed as $V = (k_{1,d} + k_2[2])[1]$, where $k_{1,d}$ and k_2 are the rate constants for the decomposition and *N*-arylcarbonylation, respectively.

The reactivity of (2) was in the order of *n*-Pr > *iso*-Pr, *iso*-Bu > *n*-Bu > *s*-Bu > *t*-Bu, *n*-Pr ≈ *n*-Bu ≈ *n*-Am and *iso*-Pr ≈ *s*-Bu because of the inductive and steric effects of the alkyl group in (2). Plots of $\log k_2$ vs. pH (pH profiles) for *N*-arylcarbonylation gave a good linear relationship in the range of $7.0 \leq \text{pH} \leq 10.0$, with a slope of 1.0. The rate (k_2) correlated with Hammett σ , giving a positive ρ of 1.2~1.3 for meta-substituted (1). The rates for ortho-substituted (1) were slower than those expected from the ionization constant of the corresponding benzoic acid, and the reactivity was in the order of *o*-F > *o*-Cl > *o*-Br due to the steric effect of the substituents. The rate ratios, $10^{-3}k_2/k_{1,d}$ increased with basicity of the solvent (pH) for both ortho- and meta-substituted (1). These ratios exceeded unity for (2) with a straight chain but less than unity for 1-alkylated (2).

Based on the above observations, a possible mechanism is proposed and discussed.

1 Introduction

The carbonyl group of carboxylic acid is activated by the derivatization to *N*-succinimidyl ester, which reacts specifically with amino group in sphingolipid base^{1),2)} and amino acid ester³⁾. In the previous papers on the reactions with amino compounds, we demonstrated that *N*-acyloxysuccinimide could be applicable as an *N*-acylation reagent to the *N*-acylation of amino compound in aqueous solution^{4),5)} and the chemical modification of Lys residues in proteins⁶⁾.

Recently, it was also reported that *N*-succinimidyl benzoate (1) reacted with amino acids in aqueous solution to give the corresponding *N*-(arylcarbonyl)amino acids⁷⁾, and that (1) could be applicable as an *N*-arylcarbonylation reagent to the chemical modification of proteins⁸⁾. In the present paper, we

selected aliphatic primary amines (2) as substrates and studied kinetically the *N*-arylcarbonylation of (2) by (1) in aqueous solution to discover a possibility as a labelling reagent for the amino compounds which do not have absorbance at 254 or 280 nm, and the precise mechanism of the *N*-arylcarbonylation by (1).

2 Experimentals

2.1 Materials

Aliphatic primary amines (2) (GR grade, purchased from Wako Pure Chemicals) were purified by distillation and dried over mole-

(1)

- a : X = *m*-CH₃ b : X = H c : X = *m*-CH₃O
 d : X = *m*-F e : X = *m*-Cl f : X = *m*-Br
 g : X = *o*-F h : X = *o*-Cl i : X = *o*-Br

*1 Chemistry of Succinimido Esters. VII. Ref. 8).

cular sieves. *N*-Succinimidyl benzoates (1) were prepared by the previously reported method⁹⁾ using DSC*². Purity of (1) exceeded 99% by GLC and HPLC analyses. Buffers: pH 7.0~8.0, 0.1 M NaH₂PO₄-Na₂HPO₄; pH 8.0~9.0, 0.1 M NaH₂PO₄-Na₂B₄O₇; pH 9.5~10.5, 0.1 M Na₂B₄O₇-NaOH.

2.2 Rate measurement

UV analyses were performed by the JASCO-430 UV Spectrophotometer equipped with the EHC-363 cell holder (JASCO). The rate was measured spectrophotometrically by following the extinction of absorbance at 258 nm of *N*-hydroxysuccinimide (4) formed during the reaction. The reaction was carried out in a cuvette (light path length: 1 cm). Since (1) was insoluble and decomposed in buffer solution, (1) was dissolved in dioxane and an aliquot (10~50 μ L) was added to the reaction solution (3 mL). Furthermore, the esters (1) were limited to ortho- and meta-substituted compounds because the absorbance of para-substituted (1) disturbed the rate measurement. The apparent first order rate constant, $k_{1,a}$, was calculated from the slope of $\ln(A_{\infty}-A_t)$ vs. t (reaction time) plot using the NEC personal computer, where A_{∞} and A_t are the absorbances at time of infinity and t , respectively. The correlation factors were more than 0.999 for all cases.

3 Results

3.1 Rate equation

The reaction of (1) with (2) to give the corresponding *N*-(arylcabonyl)amine (3) was studied kinetically at 25°C in aqueous solution (7.0 $\leq$ pH $\leq$ 10.5). The apparent first order rate constant, $k_{1,a}$, was invariable and independent of the initial concentration of neutral salts such as potassium chloride and sodium chloride, *i.e.*, no ion strength effect was observed. Thus, the rate was measured in 0.1 M buffer in the present studies. Furthermore, we employed the

reaction condition of $[2]_0 > [1]_0$ to simplify the kinetics.

(2) : Amine R = *n*-Pr, *iso*-Pr, *iso*-Bu, *n*-Bu, *s*-Bu, *t*-Bu, *n*-Am

(3) : *N*-(Arylcabonyl)amine

(4) : *N*-Hydroxysuccinimide

The effect of the initial concentration of (2) on the *N*-arylcabonylation of (2) by (1) was investigated. The representative results are shown in Fig.-1. This suggests that *N*-arylcabonylation [Eq. (1)] is competitive with the decomposition of (1) [Eq. (2)] in aqueous solution, and that the rate is expressed as follows :

$$V = k_{1,a}[1] = (k_{1,d} + k_2[2])[1] \quad (3)$$

$k_{1,d}$: the first order rate constant for the decomposition of (1)

k_2 : the second order rate constant for the *N*-arylcabonylation of (2) by (1).

The second order rate constant, k_2 , was also invariable and independent of the initial concentrations of both substrates for all cases. Thus, the rate constants were calculated by the following equation :

$$k_2 = \frac{k_{1,a} - k_{1,d}}{[2]_0} \quad (4)$$

3.2 Reactivity of (2)

The rates for the *N*-arylcabonylation of (2)

A : (1e), B : (1b), pH 9.0.

Fig.-1 The representative plots of $k_{1,a}$ vs. $[2]_0$ for the *N*-arylcabonylation of (2) by (1) in aqueous solution at 25°C.

*2 Abbreviations

DSC : *N,N'*-Disuccinimidyl carbonate, $\log(K/K_0)$: The relative strength of substituted benzoic acids, where K_0 and K are the ionization constants for non-substituted and substituted benzoic acids, respectively. $10^{-3} k_2/k_{1,d}$: The rate ratio at $[2]_0 = 10^{-3}$ M.

by (1) were measured at 25°C. The representative results (pH 9.0) are listed in **Table-1**. This shows that the rate was in the order of $n\text{-Pr} > iso\text{-Pr}$, $iso\text{-Bu} > n\text{-Bu} > s\text{-Bu} > t\text{-Bu}$, $n\text{-Pr} \approx n\text{-Bu} \approx n\text{-Am}$ and $iso\text{-Pr} \approx s\text{-Bu}$. These suggest that the reactivity is predominated by the inductive and steric effects of alkyl group in (2). The similar reactivity was observed for other pHs.

3.3 Effect of pH (pH Profile)

The effect of basicity of solvent (pH) on the *N*-arylcabonylation of (2) by (1) was investigated at 25°C in the range of $7.0 \leq \text{pH} \leq 10.5$ because the reaction at $\text{pH} > 11.0$ was too fast

Table-1 The second order rate constants, k_2 , for the *N*-arylcabonylation of (2) by (1) in aqueous solution at 25°C.

X in (1)	k_2 ($\text{M}^{-1}\text{s}^{-1}$) at pH 9.0						
	<i>n</i> -Pr	<i>iso</i> -Pr	<i>iso</i> -Bu	<i>n</i> -Bu	<i>s</i> -Bu	<i>t</i> -Bu	<i>n</i> -Am
<i>m</i> -CH ₃	4.3	0.76	5.8	4.0	0.82	0.09	4.3
H	4.9	0.82	6.5	4.2	0.85	—	5.2
<i>m</i> -CH ₃ O	7.0	1.27	9.4	6.3	1.29	—	7.0
<i>m</i> -F	13.7	2.36	17.7	12.4	2.30	—	13.1
<i>m</i> -Cl	15.1	2.67	18.9	14.2	2.58	0.26	14.2
<i>m</i> -Br	15.3	2.50	19.4	13.8	2.66	—	13.7
<i>o</i> -F	20.4	3.78	25.3	18.5	3.65	—	20.3
<i>o</i> -Cl	10.9	1.73	13.6	10.1	1.59	—	11.1
<i>o</i> -Br	7.9	1.16	9.9	7.6	1.09	—	8.3

Fig.-2 The representative plots of $\log k_2$ vs. pH for the *N*-arylcabonylation of (2) by (1) at 25°C.

to measure the rate. The representative pH profiles (plots of $\log k_2$ vs. pH) are illustrated in **Fig.-2**. These show that the rate increase linearly with increasing the basicity of solvent and the slopes of $\log k_2$ vs. pH plots are about unity at $\text{pH} \leq 10.0$. The similar tendency was observed for other reactions.

3.4 Substituent effect of (1)

The effect of substituent in (1) on the *N*-arylcabonylation was investigated using nine kinds of (1) at 25°C. The representative rate constants are also listed in **Table-1**.

The rate for the *N*-arylcabonylation by *m*-substituted (1) correlated with $\log (K/K_0)$ value*² of the corresponding benzoic acid, i.e., the $\log k_2$ vs. $\log (K/K_0)$ plots gave good linear relationship, giving a positive slope of $+1.2 \sim 1.3$. The representative results are illustrated in **Fig.-3**. The slope for the *N*-arylcabonylation of (2) is invariable and independent of the structure of (2) as shown in **Table-2**.

On the other hand, the rate for *o*-substituted (1) decreased with increasing the $\log (K/K_0)$ value as shown in **Fig.-3**. Furthermore, the reactivity of *o*-substituted (1) was in the order of $o\text{-F} > o\text{-Cl} > o\text{-Br}$ (**Table-1** and **Fig.-3**). **Fig.-3** also shows that the rate for *o*-substituted (1) is slower than that expected from the $\log (K/K_0)$ value. The slopes of $\log k_2$ vs. $\log (K/K_0)$ plots [in the present paper, the slope for *o*-substituted (1) was defined as $\text{Slope} = \Delta \log k_2 / \Delta \log (K/K_0)$ between (1g) and (1h)] are also summarized in **Table-2**. This shows that the slopes for the *N*-arylcabonylation by *o*-substituted (1) are negative and that the slopes for (2) with straight chain and isobutyl are slightly larger than those for (2) with branched (1-alkylated) chain.

The effect of pH on the slopes of $\log k_2$ vs. $\log (K/K_0)$ plots

Fig.-3 The representative plots of $\log k_2$ vs. $\log (K/K_0)$ for the *N*-arylcarbonylation of (2) by (1) at 25°C.

Table-2 Slopes of $\log k_2$ vs. $\log (K/K_0)$ plots for the *N*-arylcarbonylation of (2) by (1) at 25°C and pH 9.0.

R in (1)	<i>m</i> -Substituted (1) ^{a)}	<i>o</i> -Substituted (1) ^{b)}
<i>n</i> -Pr	+1.22	-0.80
<i>iso</i> -Pr	+1.24	-1.00
<i>iso</i> -Bu	+1.26	-0.79
<i>n</i> -Bu	+1.30	-0.77
<i>s</i> -Bu	+1.26	-1.06
<i>t</i> -Bu	+1.22 ^{c)}	—
<i>n</i> -Am	+1.20	-0.75

a) The slopes were almost same as Hammett ρ values.

b) Slopes between (1g) and (1h).

c) Slope between (1b) and (1e).

was also investigated. The representative results are shown in Fig.-4. This shows that the slope is constant and independent of the basicity of solvent (pH). The similar constancy was observed for other amines.

The rate for the *N*-arylcarbonylation by *m*-substituted (1) was also correlated with Hammett σ value. The representative $\log (k_X/k_H)$ vs. σ plots are shown in Fig.-5, where k_X and k_H are the second order rate constants of *m*-substituted and non-substituted (1), respectively. Fig.-5 shows that Hammett ρ value is positive and that the ρ value for *n*-butylamine is same as that for *s*-butylamine. The similar linearity and ρ values were observed for other amines. The ρ values were also invariable

Fig.-4 Effect of pH on the slope of $\log k_2$ vs. $\log (K/K_0)$ plot for the *N*-arylcarbonylation of (2) by (1) at 25°C.

Fig.-5 The representative Hammett plots ($\log k_X/k_H$ vs. σ) for the *N*-arylcarbonylation of (2) by (1) at 25°C.

and independent of pH.

3.5 Rate ratio

The rate ratio, $10^{-3}k_2/k_{1,d}^{*2}$, for the reaction of (1) with (2) in aqueous solution was calculated and the efficiency of (1) as an *N*-arylcarbonylation reagent was evaluated. The representative results are shown in Table-3. These show that the ratio is larger than unity for *m*-substituted (1), however, smaller than unity for *o*-substituted (1) except (1g) at pH < 9.5.

The effect of basicity of solvent (pH) on the rate ratio was also investigated in the range of $7.0 \leq \text{pH} \leq 10.5$ at 25°C. The representative results are shown in Fig.-6. This shows that the rate ratio increases with increasing pH. The similar tendency was observed for other reactions.

Table-3 The rate ratios, $10^{-3}k_2/k_{1,d}$, for the reaction of (1) with (2) in aqueous solution at 25°C.

X in (1)	$10^{-3}k_2/k_{1,d} (M^{-1})$ at pH 9.0						
	<i>n</i> -Pr	<i>iso</i> -Pr	<i>iso</i> -Bu	<i>n</i> -Bu	<i>s</i> -Bu	<i>t</i> -Bu	<i>n</i> -Am
<i>m</i> -CH ₃	2.3	0.4	3.1	2.1	0.4	<0.1	2.2
H	2.2	0.4	2.9	1.9	0.4	—	2.3
<i>m</i> -CH ₃ O	2.7	0.5	3.6	2.4	0.5	—	2.7
<i>m</i> -F	3.5	0.6	4.5	3.1	0.5	—	3.3
<i>m</i> -Cl	3.7	0.7	4.7	3.5	0.6	<0.1	3.5
<i>m</i> -Br	3.6	0.6	4.6	3.3	0.6	—	3.2
<i>o</i> -F	5.4	1.0	6.7	4.9	1.0	—	5.3
<i>o</i> -Cl	3.2	0.5	4.0	3.0	0.5	—	3.3
<i>o</i> -Br	2.3	0.3	2.9	2.2	0.3	—	2.4

Fig.-6 Effect of pH on the rate ratio for the reaction of (1) with (2) at 25°C in aqueous solution. Plots of $10^{-3}k_2/k_{1,d}$ vs. pH.

The ratio for *m*-substituted (1) was in the order of (1a) ≅ (1b) < (1c) < (1d) < (1e) < (1f), i.e., the ratio increased with increasing the strength of electron-withdrawing nature of the substituent in (1). On the other hand, the ratio for *o*-substituted (1) was in the order of (1g) > (1h) > (1i), i.e., the ratio decreased with increasing the acidity of the corresponding benzoic acid to (1), and also with increasing the steric hindrance of *o*-substituent in (1). The above tendency was observed for the reactions of (1) with other amines (2) in the range of $7.0 \leq \text{pH} \leq 10.5$.

4 Discussion

4.1 Mechanism

The *N*-arylcabonylation of (2) by (1) [Eq. (1)] was competitive with the decomposition of (1) [Eq. (2)] in aqueous solution (Fig.-1). The similar competition was reported for the *N*-acylation of amino compounds^{4),5)} and the chemical modification⁶⁾ of bovine serum albumin by *N*-acyloxysuccinimide. It was also reported that the *N*-arylcabonylation of amino acids by (1) was competitive with the decomposition of (1) in aqueous solution⁷⁾. Thus, such a competition may be generally observed for the reaction of succinimido esters in aqueous solution.

The rate showed first order dependence on the concentration of (2) [Fig.-2 and Eq. (3)], which shows that the *N*-arylcabonylation involves participation of (2) in the rate-determining step. This is supported by the fact that the slope for the pH profile was unity (Fig.-2). It was reported that the slope of the pH profile was unity for the *N*-acylation of amino compounds by *N*-acyloxysuccinimide^{4),5)}. The rate for the *N*-arylcabonylation by *m*-substituted (1) correlated with Hammett σ value, giving positive ρ value (+1.2~1.3) (Fig.-5 and 3.4). It was reported that the rate for the *N*-acylation was in the order of CN=2>3>4~8 (where CN is carbon number of acyl group in *N*-acyloxysuccinimide) because of the inductive effect of the alkyl group^{4),5)}. The positive ρ values were also reported for the *N*-arylcabonylation of amino acids by (1) in aqueous solution⁷⁾.

From the above facts, a possible mechanism involving a nucleophilic attack of free amino group in (2) on the ester carbonyl carbon in (1) was concluded for the *N*-arylcabonylation of (2) by (1) in aqueous solution.

4.2 Reactivity of (2)

The reactivity of (2) for the *N*-arylcabonylation by (1) was *n*-Pr > *iso*-Pr, *iso*-Bu > *n*-Bu > *s*-Bu > *t*-Bu, *n*-Pr ≅ *n*-Bu ≅ *n*-Am, and *iso*-Pr ≅ *s*-Bu. These demonstrates that the steric hindrance of 1-alkylated amines and the inductive

effect of alkyl group in (2) predominated the reactivity. Similar reactivity was observed for the *N*-acylation by *N*-acyloxysuccinimide in aqueous solution⁴⁾. It was reported that the rate for the *N*-arylcarbonylation of amino acids by (1) at pH=p*K_a* correlated positively with p*K_a* (nucleophilicity) of amino group in amino acids⁵⁾. Unfortunately, we could not compare the rate for the *N*-arylcarbonylation of (2) with those for amino acids at pH=p*K_a* because the rate was too fast to measure at pH>11.0 (3.3).

4.3 Substituent effect of (1)

The rate for the *N*-arylcarbonylation of (2) by *m*-substituted (1) correlated with Hammett σ value, giving positive ρ value (+1.2~1.3) (3.4 and Fig.-5). These ρ values are invariable and independent of pH and the structures of (2). A positive ρ value (+1.27) was observed for the *N*-arylcarbonylation of 6-aminoheptanoic acid by (1) at pH=p*K_a*=10.75⁷⁾. It was also reported that the rate was in the order of CN=2>3>4~8 for the *N*-acylation of amino compounds by *N*-acyloxysuccinimide because of the inductive effect^{4),5)}. The above facts demonstrate that the reactivity of (1) was predominated by the electron deficiency on ester carbonyl carbon in (1).

The rate for the *N*-arylcarbonylation of (2) by *o*-substituted (1) decreased with increasing log (*K*/*K₀*) of the corresponding benzoic acid (Fig.-3). The decrease in rate correlated with the order of steric hindrance (bulkiness) of *o*-substituent in (1). The similar decrease in rate (*o*-Cl>*o*-Br) was also observed for the *N*-arylcarbonylation of amino acids by (1).

The slopes of log *k₂* vs. log (*K*/*K₀*) plots were invariable and independent of pH as shown in Fig.-4. This figure also shows that the slopes for *m*-substituted (1) are invariable and independent of the structures of (2), and that the slopes for the *N*-arylcarbonylation of straight chain amine (*n*-butyl) by *o*-substituted (1), however, are slightly larger than those for 1-alkylated amine (*s*-butyl). These observations suggest that the steric effect of (2) for the *N*-arylcarbonylation by *o*-substituted (1) is slightly more significant than that by *m*-substituted.

4.4 Rate ratio

The ratios, $10^{-3}k_2/k_{1,d}$, were larger than unity for the *N*-arylcarbonylation of straight chain and isobutylamines (Table-3). This demonstrates that the efficiency of (1) as an *N*-arylcarbonylation reagent in more than 50% at [Amine]₀=10⁻³ M in aqueous solution. However, the ratios for 1-alkylated amines were less than unity except for the *N*-arylcarbonylation by (1g) at pH<9.5 because of the steric hindrance of (2) (Fig.-6). The ratio for *m*-substituted (1) increased with increasing the strength of electron-withdrawing nature of the substituent in (1), and the ratio for *o*-substituted (1) decreased with increasing the steric hindrance of the substituent in (1). It was reported that the rate ratios decreased with increasing CN in *N*-acyloxysuccinimide for the *N*-acylation of amino compounds, in agreement with the inductive effect^{4),5)}. The above facts suggest that the reactivity of (1) and (2) reflects roughly on the rate ratio.

The rate ratio increased with increasing basicity of solvent (pH) for the *N*-arylcarbonylation of (2) by (1) in aqueous solution (Fig.-6). This demonstrates that the efficiency of (1) as an *N*-arylcarbonylation reagent at high pH was greater than that at low pH. From the above observations, it is concluded that *N*-arylcarbonylation of amino compounds by (1) is suitable at high pH if *N*-(arylcarbonyl) amino compounds are stable in it. It was reported that the rate ratio maximized at about pH=0.6 p*K_a*+3.0 for the *N*-acylation of amino acid by *N*-acyloxysuccinimide in aqueous solution⁵⁾. Although the results in Fig.-6 seem to be strange, they are reasonable because p*K_a* of aliphatic primary amines are about 12~13.

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スクシンイミドエステルの化学

(第8報)

水溶液中での *N*-スクシンイミジルベンゾエートによる脂肪酸第一級アミンの *N*-アリアルカルボニル化反応の速度論的研究

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N-スクシンイミジルベンゾエート (1) と脂肪酸第一級アミン (2) (RNH_2 : $\text{R} = n\text{-Pr}$, *iso*-Pr, *iso*-Bu, *n*-Bu, *s*-Bu, *t*-Bu, *n*-Am) との反応を 25°C, 水溶液中 (7.0 ≤

pH ≤ 10.5) で速度論的に検討した。(1) による (2) の *N*-アリアルカルボニル化は (1) の分解と競争的に起こり, 速度は $V = (k_{1,d} + k_2[2])[1]$ で表すことができた。ここで, $k_{1,d}$ 及び k_2 はそれぞれ分解及び *N*-アリアルカルボニル化の速度定数を示す。

(2) のアルキル鎖の誘起効果及び立体障害のため, その反応性は $n\text{-Pr} > \textit{iso}\text{-Pr}$, $\textit{iso}\text{-Bu} > n\text{-Bu} > s\text{-Bu} > t\text{-Bu}$, $n\text{-Pr} \approx n\text{-Bu} \approx n\text{-Am}$, $\textit{iso}\text{-Pr} \approx s\text{-Bu}$ の順であった。log k_2 vs. pH のプロット (pH プロファイル) は $7.0 \leq \text{pH} \leq 10.0$ で良好な直線性を示し, その傾きは 1.0 であった。メタ置換 (1) による *N*-アリアルカルボニル化の速度は Hammett の σ 値と正の相関性を示し, ρ 値は +1.2~1.3 であった。オルト置換 (1) の場合, 速度は相当する安息香酸のイオン化定数から期待されるものよりも遅く, 置換基の立体障害のためその反応性は $o\text{-F} > o\text{-Cl} > o\text{-Br}$ の順であった。速度比, $10^{-3} k_2/k_{1,d}$, はオルト, メタ置換いずれの場合も溶媒の塩基度 (pH) とともに増加した。直鎖及び *iso*-Bu 基を有する (2) では, 速度比は 1.0 よりも大きかったが, 1 位にアルキル鎖を有する場合は 1.0 よりも小さいことが分かった。

以上の結果から, 可能な機構を示し, 考察を行った。

国際油脂情報

[INFO 10 号 (1987) 吉 富 和 彦]

☆ Ferruzzi 社, セントラル, ソーヤ社を買収

イタリアのラベナにある Ferruzzi グループが抱える Ferruzzi Agricola Finanziario 社は, 10 月中旬までにインディアナ州フォート・ウェインにあるセントラル・ソーヤ社の買収を完了したい意向である。1 億 7,000 万ドルの同社買収により, Ferruzzi 社は世界の大豆製油工場における所有権を得ることになる。セントラル・ソーヤ社は世界 7 か国において 65 か所の工場を操業している。その中には年間総処理能力 1 億 5,000 万ブッシェル (408 万トン) に及ぶ 9 か所の大豆製油工場と, 3 か所の年間大豆油処理能力 8 億 7,500 万ポンド (約 40 万トン) の精製工場が含まれる。Ferruzzi 社はイタリアとスペインで 7 か所の製油工場, ヨーロッパで 13 か所のとうもろこしと小麦の湿式製粉工場, ならびにイタリアとフランスで 24 か所の甜菜製糖工場を抱えており, 年間総売上高は約 180 億ドル (2 兆 5,700 億円) に達する。一方, セントラル・ソーヤ社は年間総売上高約 15 億ドル (2,150 億円) である。

☆ AOCS 新本部, 11 月 6~7 日開所へ

アメリカ油化学協会 (AOCS) の新本部ビルの正式な開所式が, イリノイ州シャンペーンにおいて, 11 月 6~7 日に開催される。11 月 6 日 (金) には 21 世紀を目指した油脂関連の将来性に関するパネル討論会が行われる。討論は研究企画, 栄養, 油脂化学, セッケン, 洗剤などのテーマが焦点になる。当日夕方にはセントラル・ソーヤ社の D.H. Swanson 社長が AOCS 中北部の晩さん会においてスピーチを行う。7 日 (土) には新ビルにおいて簡単なテーブルカット式が行われ, 続いて観光ツアーおよび朝食会がある。

☆ ボーデン社, スナック食品会社を買収

ボーデン社の発表によれば, 同社はカリフォルニアに本拠を置くポテトチップス, ピーナツバターその他のスナック食品の生産販売会社の Laura Scudder's 社を買収した。このカリフォルニアの会社は 1986 年の売上高 1 億 2,500 万ドルで, ボーデン社では今回の買収により同社のスナック食品販売量が約 40% 伸び, 売上高は約 7 億ドルになろうとしている。