Summary

Mixed sucrose stearates extracted from alcoholyses products at various molar ratios of sucrose/methyl stearate were separated by liquid column chromatography, and the contents of sucrose monostearate were determined. According to the comparison of the observed values with the theoretical ones, it was concluded that the composition of the alcoholysis product is governed by the random distribution rule, and it can be predicted by calculation with this rule. The compositions of various products were shown.

(Received August 21, 1962)

UDC 547.458.2'29

87. **Kazuya Kunugi**: Studies on the Syntheses of Sucrose Fatty Acid Esters. III. Re-esterification of Sucrose Monostearate.

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In the previous paper of this series,[*2] the author reported that the composition of the alcoholyses products of fatty acid esters with sucrose were governed by the random distribution rule. The above conclusion was obtained from comparison of the observed contents of free sucrose and sucrose mono-stearate in the alcoholysis product with the theoretical values calculated by the random distribution rule.

In the present work, the author attempted to investigate this rule concerning with re-esterification of a sucrose stearate. The random distribution rule was proposed by Bailey[1] in order to calculate the composition of a re-esterified fat, assuming that the acyl radicals would migrate and distribute randomly on glycerol molecules in the presence of catalyst. According to this assumption, it is regarded that, in the case of sucrose stearate, the composition of inter molecular-esterification products depends upon the molar ratio of sucrose/stearoyl radical, and is independent on the structures of the ingredients used.

Osipow, *et al.*,[2] had suggested that re-esterification of sucrose polyester with addition of excess sucrose would produce sucrose monoester, and this suggestion had been confirmed in this laboratory.

On the contrary, by re-esterification of sucrose partially substituted stearate, sucrose and higher polystearate can be obtained in consequence of random distribution. In this work, this possibility was investigated in the case of re-esterification of sucrose monostearate.

Since sucrose monostearate can be obtained more easily than other various stearates by recrystallization of the alcoholysis product obtained from the reaction mixture of excess sucrose and methyl stearates, it was chosen as a typical compound of partially substituted stearates.

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*2 Part II : This Bulletin, **11**, 482 (1963).

1) A. E. Bailey : "Industrial oil and fat products." 834, Interscience Publishers INC., New York (1951).

2) L. Osipow, *et al.* : Ind. Eng. Chem., **48**, 1459 (1956).

Sucrose monostearate was dissolved in dimethylformamide and treated in the presence of K_2CO_3 (catalyst) at the condition similar to the alcoholysis of sucrose and methyl stearate, but without distillation.

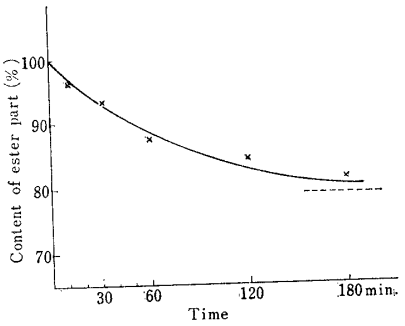

Fig. 1. Decrease of Ester Part by Re-esterification of Sucrose Monostearate (Dotted line indicates the theoretical value.)

By sampling of the reaction mixture during re-esterification, the amount of "Ester Part,"*3 i.e., the sum of sucrose mono-, di-, tri- and higher poly-stearates, was determined. As shown in Fig. 1, Ester Part in dry product was reduced from 100 to about 80% in the period of 3 hours, and re-esterification reached to an equilibrium. This showed that about 20% of free sucrose was produced.

The content of sucrose monostearate in Ester Part after re-esterification was determined by liquid column chromatography. The experimental results were shown in Table I.

The molar ratio of sucrose/stearoyl radical in sucrose monostearate is 1, apparently. In this re-esterification, however, small amount of potassium stearate was produced as the side-reaction product. Therefore, the molar ratio of sucrose/esterified stearoyl radical was changed to more than 1 by this side-reaction, and was 1.07 in this case.

On the other hand, the composition of re-esterified product can be calculated from probability considerations according to the random distribution rule, when the molar ratio of sucrose/acyl radical is known. The calculated value of the composition was also shown in Table I, in which the molar ratio was 1.07. The method of calculation was referred to the previous report.*2

Concerning with the contents of Ester Part in dry product and of sucrose monostearate in Ester Part, comparison of the observed and the theoretical values gave a good accordance. Therefore, it was concluded that the re-esterification of sucrose esters was able to be explained by the random distribution rule as well as re-esterified fat. The composition of the re-esterification product of sucrose monostearate was similar to the alcoholysis product in which the molar ratio of sucrose/methyl stearate was nearly equal to 1.

It was also concluded that polystearates, e.g., sucrose di- and tri-stearate, were produced as shown in Table I.

Table I. Composition of Re-esterified Product from Sucrose Monostearate

	Calcd.	Found
Ester Part in dry product	78.6	81.4
Sucrose monostearate in Ester Part	51.4	47.5
distearate	34.1	—
tristearate	11.8	—
tetrastearate	2.4	—
pentastearate	0.3	—

*3 Cf. the previous report of this series (this Bulletin, **11**, 478 (1963).

Table II. Ester Part at a Various Period of Re-esterification of Sucrose Monostearate

Time (min.)	BuOH extract (%)	Ester Part (%)
10	96.3	96.1
30	93.6	93.4
60	88.2	87.6
120	85.1	84.5
180	82.1	81.4

Experimental

Sucrose Monostearate——The procedure which was developed by Osipow, *et al.*, was principally applied. 3 moles of sucrose, 1 mole of methyl stearate and 12 g. of K_2CO_3 were dissolved in 2 L. of dimethylformamide, and the reaction mixture was boiled under 92 ± 3 mm. of mercury pressure, MeOH formed during reaction was stripped off through a fractionating column. The period of reaction was 5 hr. After completion of the reaction, to one volume of reaction mixture two volumes of BuOH and three volumes of 15% aqueous solution of NaCl were added, and the resulting two layers were separated. The upper layer (BuOH solution) was washed with aqueous solution of NaCl, and cooled to 5°. The resulting precipitate was filtered off, and the filtrate was concentrated to dryness in a reduced pressure. The residue was purified by recrystallization from Me_2CO repeatedly. Saponification value: 93.2 (Calcd. 92.6). $[\alpha]_D^{20}$ in EtOH $+37.5°$.

Re-esterification of Sucrose Monostearate——50 g. of sucrose monostearate and 2 g. of K_2CO_3 were dissolved in 150 cc. of dimethylformamide, and the mixture was stirred at $90\pm2°$ under refluxing. At the period of 10 min., 30 min., 60 min., 120 min., and 180 min. after the beginning of the reaction, 10 cc. of reaction mixture was sampled and after each sample was neutralized to pH 6.0 with conc. H_2SO_4, 50 cc. of BuOH and 50 cc. of 10% aqueous solution of NaCl were added. The resulting two layers were separated, and the aqueous layer was washed with 40 cc. of BuOH twice. The BuOH layer and washings were combined and washed twice with 40 cc. of 10% aqueous solution of NaCl, and after the solution was concentrated to dryness, the residue (BuOH extract) was weighed. On the other hand, 10 cc. of reaction mixture was dried by distillation of dimethylformamide, and the residue (dry product) was weighed. Thus, σ, *i.e.*, the percentage of BuOH extract in dry product can be calculated.

By measurement of acid value of BuOH extract, γ, *i.e.*, the content of free stearic acid in dry product was determined. Therefore, E, *i.e.*, the content of Ester Part was calculated by the following equation.

$$E=\frac{\sigma-\gamma}{100-\gamma}\times100 \qquad (1)$$

Ester Part at a various period of re-esterification was shown in Table II and Fig. 1.

The content of free stearic acid in BuOH extract, which was obtained after re-esterification of 3 hr., was 4.04%. Then, m, *i.e.*, the molar ratio of sucrose/esterified stearoyl radical was calculated by the following equation.

$$m=\frac{M_s-18\times\frac{x}{100}}{M_s-(M_h+M_s)\frac{x}{100}} \qquad (2)$$

where: x is percentage of free stearic acid in dry product, M_s and M_h are molecular weight of stearic acid and sucrose respectively.

Thus, m was 1.07 in this case. Details with respect to equation (2) were reported in the previous paper of this series.*3

Determination of the Content of Sucrose Monostearate by Liquid Column Chromatography——BuOH extract, which was obtained after re-esterification of 3 hr., was taken as the sample for chromatography.

2.5 g. of sample was chromatographed with a column packed with 50 g. of acidified alumina powder. Benzene-BuOH (9:1 v./v.) and BuOH saturated with H_2O were used as solvents for development and elution. Details of the procedure were reported in the previous paper of this series.[3] The portion of the second fraction in the sample was 83.9%, and saponification value of this portion was 108.2. From these values, the content of sucrose monostearate was calculated as 47.5%.

3) Part II: This Bulletin, **11**, 482 (1963).

The author expresses his sincerest gratitude to Prof. Dr. T. Ukita, University of Tokyo, and to Prof. Dr. T. Kwan, University of Tokyo, for their kind guidance. The author is deeply grateful to Mr. T. Shoji, the President of this Company, to Mr. J. Huruyama, the executive managing Director of this Company, and to Dr. H. Murata, the Director of this Laboratory, for their guidance and encouragement throughout the course of the present work and for giving permission for publication of this work.

Summary

Re-esterification of sucrose monostearate at the condition similar to the alcoholysis reaction was investigated. Sucrose and sucrose polystearate, e.g., di- and tri-stearate, were produced as a result of re-esterification. It was concluded that the composition of the product gave a good accordance with the values calculated by the random distribution rule. Equilibrium was reached in about three hours.

(Received August 21, 1962)

UDC 615.783.19-092

88. Goro Hayashi,[*1] Mikio Takeda,[*1] Hiroshi Kugita,[*1] Norio Sugimoto,[*1] and Hajime Fujimura[*2]: The Preparative and Pharmacological Studies of *levo* and *dextro* 9-Aza-des-N-morphinan (2,3,4,4*a*-Tetrahydro-1*H*,6*H*-5,10*b*-propanophenanthridin-9-ol).

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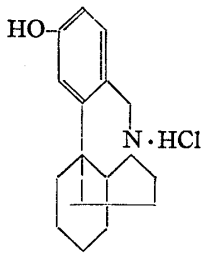
An isomer of morphinan, 9-aza-des-N-morphinan, DH-7 (2,3,4,4*a*-tetrahydro-1*H*,6*H*-5,10*b*-propanophenanthridin-9-ol) was first synthesized by Sugimoto, *et al.* in 1955.[1] In a recent communication[2] the pharmacological studies of this compound has been detailed by Fujimura, *et al.*



This paper concerns with the preparation and pharmacological evaluation of optical active forms of DH-7, the *dextro*-(DH-14) and *levo*-(DH-15) isomers.

Optical resolution

Direct resolution of the racemate (DH-7) with various optical acids were without success. Efforts were then turned to the resolution of (±)-3-methoxy-9-aza-des-N-morphinan, a prior compound of DH-7. *d*-Tartaric acid formed crystalline salts with the optical isomers of the methoxy compound, which upon recrystallization separated the salt of the *dextro*-isomer. Crude salt of the *levo*-isomer from the mother liquor could not be purified by recrystallization. Conversion of the crude salt to free base and in turn to the *d*-camphor-*β*-sulfonate afforded a well-defined salt of the *levo*-isomer. One-step separation of the *levo*-isomer from the racemate with *d*-camphor-*β*-sulfonic acid was unsuccessful.

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1) N. Sugimoto, H. Kugita: This Bulletin, **3**, 11 (1955).
2) H. Fujimura, N. Sugimoto, G. Hayashi: Japanese J. Pharmacol., **11**, 101 (1962).