Staphylococcus piscifermentans sp. nov., from Fermented Fish in Thailand

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New coagulase-negative staphylococci were isolated from fermented fish in Thailand. These organisms were differentiated from other *Staphylococcus* species on the basis of DNA relatedness and biochemical characteristics. *Staphylococcus piscifermentans* sp. nov. is described, and the type strain is strain SK03 (= NRIC 1817 = JCM 6057 = TISTR 824).

In studies of lactic acid bacteria isolated from fermented foods in Thailand, a number of lactobacilli and pediococci and a small number of coagulase-negative staphylococci were isolated (28-31). Several staphylococcal strains isolated from fermented fish and soy sauce mash were identified as *Staphylococcus carnosus* (30), and other strains were not identified. In this paper we describe a new species, *Staphylococcus piscifermentans*, for these previously unidentified staphylococci.

MATERIALS AND METHODS

Bacterial strains. Ten strains were isolated from fermented fish in Thailand (29, 30). The designations and isolation sources of these strains are shown in Table 1. The reference strains which we used are shown in Table 2.

Characteristic determinations. In this study, glucose-yeast extract-peptone medium (30) was used as a basal medium. The following characteristics were determined as described previously (29-31): cell and colonial morphology; catalase activity; benzidine test; coagulase activity; hemolysis of horse blood; oxidase, urease, and phosphatase activities; Voges-Proskauer reaction; hydrolysis of Tween 80, esculin, arginine, and gelatin; lecithovitellin reaction; nitrate reduction; utilization of citrate; oxidation-fermentation test; acid production from carbohydrates; growth in glucose-yeast extract-peptone medium containing sodium acetate and mineral salt broth (30) at different temperatures and pH values and in the presence of different concentrations of NaCl; and susceptibility to lysozyme (400 and 1,600 µg/ml), lysostaphin (200 µg/ml), and novobiocin (1.6 and 5.0 µg/ml). Anaerobic growth was determined in a semisolid thioglycolate medium (Difco Laboratories, Detroit, Mich.). β-Glucosidase, β-glucuronidase, and β-galactosidase activities were tested by using Staphyogram (Terumo Co., Tokyo, Japan). DNA base composition, cellular fatty acid composition, and quinone systems were determined as reported previously (1, 11, 20, 26, 27, 33). Fluorometric DNA-DNA hybridization in microdilution wells was carried out in 2× SSC (1× SSC is 0.15 M NaCl plus 0.015 M trisodium citrate) and a 50% formamide solution under optimal (37°C) and

stringent (45°C) conditions as described by Ezaki et al. (5, 6). Cell wall peptidoglycan was analyzed as described by Komagata and Suzuki (15). Lactic acid was extracted with ether from fermented broth containing 2% glucose, 1% yeast extract, 1% peptone, and mineral salt (30). Isomers of lactic acid were determined enzymatically by using the method of Okada et al. (18).

RESULTS

Phenotypic characteristics. The characteristics of 10 strains of *S. piscifermentans* are shown in Table 3.

DNA base composition. The DNA base compositions of *S. piscifermentans* strains ranged from 36.3 to 37.3 mol% guanine plus cytosine. These values were within the same range as the values obtained for strains belonging to other *Staphylococcus* species (Table 2).

DNA homologies. The levels of DNA relatedness between *S. piscifermentans* strains and other *Staphylococcus* species are shown in Table 2. *S. piscifermentans* SK03^T (T = type strain) exhibited high levels of DNA relatedness (more than 79%) with the other strains of this species which we tested and low levels of DNA relatedness (less than 43%) with strains belonging to other *Staphylococcus* species.

Cellular fatty acid composition. Five strains of *S. piscifermentans* had a branched-chain anteiso-C_{15:0} fatty acid as a major component. Other acids were also found (Table 4). The presence of C_{20:0} fatty acid confirmed the classification of these strains in the genus *Staphylococcus*, as reported previously (30).

Quinone systems. Ten strains of *S. piscifermentans* contained MK-7 as the major component (more than 88% of the total) and MK-6 and MK-8 as minor menaquinones (less than 12%) (30; this study).

Cell wall peptidoglycan. The peptidoglycan type of strains SK03^T, SK05, SK14, SK16, Ph78, and Ph79L was L-Lys-Gly₄₋₅.

Isomer of lactic acid. Strains SK03^T, SK05, SK14, SK16, Ph78, and Ph79L produced DL-lactic acid.

DISCUSSION

The characteristics of *S. piscifermentans* that differentiate this species from other novobiocin-susceptible staphylococ-

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TABLE 1. Designations and isolation sources of *S. piscifermentans* strains

Strain	Other designations ^a			Source ^b
	NRIC	JCM	TISTR	
SK02	1816	6056	916	Kung-chom
SK03 ^T	1817 ^T	6057 ^T	824 ^T	Kung-chom
SK04	1818	6058	825	Kung-chom
SK05	1819	6059	671	Kung-chom
SK14	1820	6061	917	Pla-ra
SK15	1821	6062	676	Pla-ra
SK16	1822	6063	918	Pla-ra
Ph78	1823	6071	827	Bu-du
Ph79S	1824	6072	828	Bu-du
Ph79L	1825	6073	677	Bu-du

^a NRIC, NODAI Research Institute Culture Collection, Tokyo University of Agriculture, Tokyo, Japan; JCM, Japan Collection of Microorganisms, RIKEN, Saitama, Japan; TISTR, Thailand Institute of Scientific and Technological Research, Bangkok, Thailand.

^b Kung-chom is fermented shrimp, pla-ra is fermented fish, and bu-du is fermented fish in liquid form.

cal species are shown in Table 5. *S. piscifermentans* and *S. carnosus* were isolated from fermented foods (30) and seem to be similar to each other in their determinative characteristics. When the characteristics of these organisms are

compared (Table 3), a combination of the urease and β -glucosidase reactions is useful for separating the two species. However, there are some exceptions in *S. piscifermentans* and *S. carnosus*. For example, 1 of 10 *S. piscifermentans* strains is urease negative, and 2 of 10 *S. carnosus* strains are positive. β -Glucosidase activity, phosphatase activity, esculin hydrolysis, and acid production from melezitose and sucrose are other variable characteristics. Therefore, these characteristics have only relative value for separating the two species. Furthermore, there are some differences between the characteristics of *S. carnosus* given in *Bergey's Manual of Systematic Bacteriology* (14) and the characteristics in Table 3; namely, the data for phosphatase, urease, β -glucosidase, and β -galactosidase activities and acid production from lactose, D-mannitol, D-mannose, D-ribose, and D-trehalose do not coincide. These discrepancies may be explained by the number of strains studied. Determination of levels of DNA relatedness is useful for correct identification of *S. piscifermentans*. The data for cellular fatty acid composition, quinone systems, peptidoglycan type, DNA base composition, and the lactic acid isomer produced support the differentiation of *S. piscifermentans* from the *Staphylococcus* species described previously (3, 4, 7–10, 12–14, 17, 19, 21–24, 30, 32).

Description of *Staphylococcus piscifermentans* sp. nov.
Staphylococcus piscifermentans (pis.ci.fer.men'tans. L. n.

TABLE 2. DNA base compositions and levels of DNA relatedness of *S. piscifermentans* and other novobiocin-susceptible *Staphylococcus* species

Strain	G+C content (mol%)	% Similarity with labeled DNA from:				Reference ^a
		Strain SK03 ^T		Strain Ph78 at 45°C	Strain Ph79L at 45°C	
		37°C	45°C			
<i>S. piscifermentans</i> SK03 ^T	36.8	100	100	114	93	
<i>S. piscifermentans</i> SK14	37.3	107	102	91	95	
<i>S. piscifermentans</i> SK02	37	99	88	— ^b	116	
<i>S. piscifermentans</i> SK04	37	99	84	103	81	
<i>S. piscifermentans</i> SK15	37.2	91	89	83	77	
<i>S. piscifermentans</i> Ph79S	37	90	70	102	—	
<i>S. piscifermentans</i> SK05	36.7	80	66	106	93	
<i>S. piscifermentans</i> Ph79L	37.1	79	65	110	100	
<i>S. piscifermentans</i> SK16	36.3	79	79	80	80	
<i>S. piscifermentans</i> Ph78	36.4	—	—	100	88	
<i>S. aureus</i> subsp. <i>anaerobius</i> GIFU 10707 ^{Tc}	31.7	16	—	—	—	2
<i>S. aureus</i> subsp. <i>aureus</i> GIFU 9120 ^T	31.2	25	—	—	—	25
<i>S. auricularis</i> GIFU 10395 ^T	38.8	17	—	—	11	13
<i>S. capitis</i> GIFU 9121 ^T	35.5	15	—	—	—	12
<i>S. caprae</i> GIFU 10757 ^T	36.1	23	—	—	17	4
<i>S. carnosus</i> GIFU 10766 ^T	36	43	—	—	37	21
<i>S. caseolyticus</i> GIFU 10760	39	10	—	—	—	23
<i>S. chromogenes</i> GIFU 12240 ^T	—	14	—	—	7	
<i>S. delphini</i> GIFU 12159 ^T	39	1	—	—	6	32
<i>S. epidermidis</i> GIFU 8656 ^T	33.5	13	—	—	—	30
<i>S. felis</i> GIFU 12627 ^T	35.2	8	—	—	4	10
<i>S. haemolyticus</i> GIFU 9124 ^T	36.4	5	—	—	—	24
<i>S. hominis</i> GIFU 9125 ^T	33.7	1	—	—	—	12
<i>S. hyicus</i> GIFU 9843	—	4	—	—	—	
<i>S. intermedius</i> GIFU 8781 ^T	33.5	5	—	—	—	8
<i>S. lugdunensis</i> GIFU 11876 ^T	32	15	—	—	19	7
<i>S. schleiferi</i> GIFU 12245 ^T	37	19	—	—	17	7
<i>S. simulans</i> GIFU 9127 ^T	34	12	—	—	7	12
<i>S. warneri</i> GIFU 9128 ^T	34.2	19	—	—	—	12

^a DNA base composition data for strains other than *S. piscifermentans* strains were obtained from references.

^b —, not determined.

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TABLE 3. Characteristics of *S. piscifermentans* and *S. carnosus*

Characteristic	<i>S. piscifermentans</i>		<i>S. carnosus</i> (10 strains) ^a
	Ten strains	Strain SK03 ^T reaction	
Catalase activity	10 ^b	+	10 ^b
Coagulase activity	0	—	0
Hemolysis of blood	0	—	0
Anaerobic growth in thio-glycolate medium	10	+	10 ^c
Benzidine test	10	+	10
Voges-Proskauer reaction	0	—	0
Oxidase activity	0	—	0
Phosphatase activity	10	+	4
Urease activity	9	+	2
β-Glucosidase activity	10	+	2 ^c
β-Glucuronidase activity	0	—	0 ^c
β-Galactosidase activity	0	—	0 ^c
Nitrate reduction	10	+	10
Hydrolysis of:			
Gelatin	0	—	0
Arginine	10	+	10
Tween 80	6	+	2
Esculin	9	+	2
Acid produced aerobically from:			
D-Arabinose	0	—	0
D-Cellobiose	0	—	0
D-Fructose	10	+	10
L-Fucose	0	—	0
D-Galactose	6	+	1
Gluconate	0	—	0
D-Glucose	10	+	10
Glycerol	4	—	2
Lactose	6	+	1
Maltose	5	+	0
D-Mannitol	3	—	2
D-Mannose	0	—	4
D-Melezitose	6	+	0
Raffinose	0	—	0 ^c
D-Ribose	3	—	3 ^c
Salicin	4	—	0 ^c
Sucrose	6	+	0
D-Sorbitol	3	—	3
D-Trehalose	10	+	10
D-Turanose	0	—	0
Xylitol	0	—	0
D-Xylose	0	—	0
Growth in the presence of 15% NaCl	10	+	9
Lysostaphin resistance (200 µg/ml)	0	—	0
Lysozyme resistance (400 µg/ml)	8	+	8
Novobiocin resistance (1.6 µg/ml)	0	—	0

^a Data from reference 30.^b Number of strains positive.^c Unpublished data.

piscis, fish; M.L. part.adj. *fermentans*, fermenting; M.L. adj. *piscifermentans*, fish fermenting). Cells are gram-positive cocci (diameter, 1.0 µm) that are nonmotile and non-sporeforming and occur singly, in pairs, in tetrads, and in clusters. Colonies on glucose-yeast extract-peptone agar are usually opaque, circular, low convex with entire margins, and nonpigmented or white with a yellowish orange tint. They are positive for catalase activity, the benzidine test, nitrate reduction, phosphatase activity, β-glucosidase activ-

TABLE 4. Cellular fatty acid composition of *S. piscifermentans*

Fatty acid	% of total in <i>S. piscifermentans</i>	
	Five strains	Strain SK03 ^T
Iso-C _{14:0}	1.3	2
C _{14:0}	0.9	1
Iso-C _{15:0}	6	10
Anteiso-C _{15:0}	35	28
C _{15:0}	0.3	— ^a
Iso-C _{16:0}	0.4	1
C _{16:0}	4.8	6
Iso-C _{17:0}	2	2
Anteiso-C _{17:0}	6.7	3
C _{18:0}	16.9	18
Iso-C _{19:0}	1.2	1
Anteiso-C _{19:0}	2.8	1
C _{20:0}	18.5	24
Unknown	1.5	1.7

^a —, not detected.

ity, and arginine hydrolysis and negative for coagulase activity, hemolysis of horse blood, oxidase activity, the Voges-Proskauer reaction, the lecithovitellin reaction, gelatin hydrolysis, citrate utilization, β-glucuronidase activity and β-galactosidase activity. Most strains are positive for hydrolysis of urea, Tween 80, and esculin. All are facultatively anaerobic and split glucose fermentatively. Acid is produced aerobically from D-glucose, D-fructose, and D-trehalose, but not from D-arabinose, D-cellobiose, L-fucose, gluconate, D-mannose, raffinose, D-turanose, D-xylose, and xylitol. Compounds which give variable acid production are shown in Table 3.

The strains grow in thioglycolate medium, grow at 18 and 42°C, and grow well between pH 6.8 and 9.0. All strains grow weakly at pH 5.0 but not at pH 4.5 and at 45°C. All strains grow in medium containing 6, 8, or 10% NaCl, and some strains grow in medium containing 15% NaCl. Susceptible to lysostaphin (200 µg/ml) and novobiocin (1.6 and 5.0 µg/ml). Most strains are resistant to lysozyme (400 and 1,600 µg/ml). Variable characteristics are shown in Table 3.

The DNA base composition ranges from 36.3 to 37.3 mol% guanine plus cytosine. The strains contain anteiso-C_{15:0} fatty acid as a dominant fatty acid. MK-7 is the major menaquinone, and MK-6 and MK-8 are minor menaquinones. The strains tested contain peptidoglycan of the L-Lys-Gly_{4,5} type and produce DL lactic acid from glucose. The strains were isolated from kung-chom (fermented shrimp), pla-ra (fermented fish), and bu-du (fermented fish in liquid form). Strain SK03 (= NRIC 1817 = JCM 6057 = TISTR 824) is the type strain and was isolated from kung-chom.

Description of the type strain. Type strain SK03 has the characteristics given above in the description of the species. The guanine-plus-cytosine content of strain SK03^T DNA is 36.8 mol% (as determined by high-performance liquid chromatography).

ACKNOWLEDGMENTS

We thank J. Sugiyama, Institute of Applied Microbiology, The University of Tokyo, Tokyo, Japan, for the Latin etymology and K. Suzuki, Japan Collection of Microorganisms, RIKEN, Wako-shi, Saitama, Japan, for helping with the analysis of cellular fatty acids and cell wall peptidoglycan.

TABLE 5. Characteristics that differentiate *S. piscifermentans* and other novobiocin-susceptible *Staphylococcus* species^{a,b}

Species	Oxidase test	Coagulase activity	Phosphatase activity	Urease activity	β-Glucosidase activity	β-Glucuronidase activity	β-Galactosidase activity	Acid produced from:						
								Maltose	Trehalose	Mannitol	Sucrose	Mannose	Ribose	Lactose
<i>S. piscifermentans</i>	-	-	+	+	+	-	-	d	+	d	-	d	+	d
<i>S. aureus</i>	-	+	+	+w	+	-	-	+	+	d	+	+	+	+
<i>S. auricularis</i>	-	-	-	-	-	-	(d)	(+)	(+)	d	-	-	-	-
<i>S. capitis</i>	-	-	-	-	-	-	-	-	-	(+)	+	+	-	-
<i>S. caprae</i>	-	-	(+)	-	-	-	+	d	+	-	+	+	+	+
<i>S. carnosus</i>	-	-	+	-	-	-	+	d	+	-	+	+	+	d
<i>S. caseolyticus</i>	+	-	+	Nd	Nd	Nd	Nd	+	-	d	+	+	+	+
<i>S. chromogenes</i>	-	-	+	d	d	-	-	d	+	+	+	+	+	+
<i>S. delphini</i>	Nd	+	+	+	Nd	Nd	Nd	+	(w)	+	+	+	Nd	+
<i>S. epidermidis</i>	-	-	+	+	(d)	-	-	-	-	+	+	(+)	d	+
<i>S. felis</i>	-	-	+	+	-	-	+	+	+	d	+	+	-w	+
<i>S. haemolyticus</i>	-	-	-	-	d	d	-	d	d	+	-	d	d	+
<i>S. hominis</i>	-	-	-	+	-	-	-	-	-	+	-	+	+	+
<i>S. hyicus</i>	-	d	+	d	d	d	-	+	+	+	+	+	+	d
<i>S. intermedius</i>	-	+	+	+	d	-	+	(d)	+	+	+	+	+	d
<i>S. lugdunensis</i>	-	-	-	d	+ ^c	-	-	+	+	+	+	+	+	+
<i>S. muscae</i>	-	-	+	-	Nd	Nd	-	+	+	+	+	-	-	+
<i>S. saccharolyticus</i>	-	-	+	+ ^c	- ^c	- ^c	- ^c	-	-	-	+	(+)	Nd	-
<i>S. schleiferi</i>	-	-	d	-	- ^c	-	- ^c	-	-	-	+	+	-	-
<i>S. simulans</i>	-	-	(d)	+	-	d	+	d	+	+	d	d	+	+
<i>S. warneri</i>	-	-	-	+	+	d	-	+	+	+	-	d	d	d

^a Data from references 7, 9, 10, 14, 16, and 32.^b +, 90% or more of the strains are positive; -, 90% or more of the strains are negative; d, 11 to 89% of the strains are positive; w, weak reaction; -w, negative to weak reaction; +w, positive to weak reaction; Nd, not determined. Parentheses indicate that the reaction was delayed.^c Data for the type strain (this study).

REFERENCES

- Collins, M. D., T. Pirouz, M. Goodfellow, and D. E. Minnikin. 1977. Distribution of menaquinones in actinomycetes and corynebacteria. *J. Gen. Microbiol.* **100**:221–230.
- De La Fuente, R., G. Suarez, and K. H. Schleifer. 1985. *Staphylococcus aureus* subsp. *anaerobius* subsp. nov., the causal agent of abscess disease of sheep. *Int. J. Syst. Bacteriol.* **35**:99–102.
- Devriese, L. A., V. Hájek, P. Oeding, S. A. Meyer, and K. H. Schleifer. 1978. *Staphylococcus hyicus* (Sompolinsky 1953) comb. nov. and *Staphylococcus hyicus* subsp. *chromogenes* subsp. nov. *Int. J. Syst. Bacteriol.* **28**:482–490.
- Devriese, L. A., B. Poutrel, R. Kilpper-Bälz, and K. H. Schleifer. 1983. *Staphylococcus gallinarum* and *Staphylococcus caprae*, two new species from animals. *Int. J. Syst. Bacteriol.* **33**:480–486.
- Ezaki, T., Y. Hashimoto, N. Takeuchi, H. Yamamoto, S. Liu, H. Miura, K. Matsui, and E. Yabuuchi. 1988. Simple genetic method to identify viridans group streptococci by colorimetric dot hybridization and fluorometric hybridization in microdilution wells. *J. Clin. Microbiol.* **26**:1708–1713.
- Ezaki, T., Y. Hashimoto, and E. Yabuuchi. 1989. Fluorometric DNA-DNA hybridization in microdilution wells as an alternative to membrane filter hybridization in which radioisotopes are used to determine genetic relatedness among bacterial strains. *Int. J. Syst. Bacteriol.* **39**:224–229.
- Freney, J., Y. Brun, M. Bes, H. Meugnier, F. Grimont, P. A. D. Grimont, C. Nervi, and J. Fleurette. 1988. *Staphylococcus lugdunensis* sp. nov. and *Staphylococcus schleiferi* sp. nov., two species from human clinical specimens. *Int. J. Syst. Bacteriol.* **38**:168–172.
- Hájek, V. 1976. *Staphylococcus intermedius*, a new species isolated from animals. *Int. J. Syst. Bacteriol.* **26**:401–408.
- Hájek, V., W. Ludwig, K. H. Schleifer, N. Springer, W. Zitzelsberger, R. M. Kroppenstedt, and M. Kocur. 1992. *Staphylococcus muscae*, a new species isolated from flies. *Int. J. Syst. Bacteriol.* **42**:97–101.
- Igimi, S., S. Kawamura, E. Takahashi, and T. Mitsuoka. 1989. *Staphylococcus felis*, a new species from clinical specimens from cats. *Int. J. Syst. Bacteriol.* **39**:373–377.
- Ikemoto, S., K. Katoh, and K. Komagata. 1978. Cellular fatty acid composition in methanol-utilizing bacteria. *J. Gen. Appl. Microbiol.* **24**:41–49.
- Kloos, W. E., and K. H. Schleifer. 1975. Isolation and characterization of staphylococci from human skin. II. Descriptions of four new species: *Staphylococcus warneri*, *Staphylococcus capitis*, *Staphylococcus hominis*, and *Staphylococcus simulans*. *Int. J. Syst. Bacteriol.* **25**:62–79.
- Kloos, W. E., and K. H. Schleifer. 1983. *Staphylococcus auricularis* sp. nov.: an inhabitant of the human external ear. *Int. J. Syst. Bacteriol.* **33**:9–14.
- Kloos, W. E., and K. H. Schleifer. 1986. Genus IV. *Staphylococcus* Rosenbach 1884, 18 (Nom. Cons. Opin. 17 Jud. Comm. 1958, 153), p. 1013–1035. In P. H. A. Sneath, N. S. Mair, M. E. Sharpe, and J. G. Holt (ed.), *Bergey's manual of systematic bacteriology*, vol. 2. The Williams & Wilkins Co., Baltimore.
- Komagata, K., and K. Suzuki. 1987. Lipid and cell-wall analysis in bacterial systematics. *Methods Microbiol.* **19**:161–207.
- Lenette, E. H., A. Balows, W. J. Hausler, Jr., and H. J. Shadomy (ed.). 1985. *Manual of clinical microbiology*, 4th ed. American Society for Microbiology, Washington, D. C.
- Nahaie, M. R., M. Goodfellow, D. E. Minnikin, and V. Hájek. 1984. Polar lipid and isoprenoid quinone composition in the classification of *Staphylococcus*. *J. Gen. Microbiol.* **130**:2427–2437.
- Okada, S., T. Toyoda, and M. Kozaki. 1978. An easy method for the determination of the optical types of lactic acid produced by lactic acid bacteria. *Agric. Biol. Chem.* **42**:1781–1783.
- O'Leary, W. M., and S. G. Wilkinson. 1988. Gram-positive bacteria, p. 117–201. In C. Ratledge, and S. G. Wilkinson (ed.), *Microbial lipids*, vol. 1. Academic Press, Ltd., London.
- Saito, H., and K. Miura. 1963. Preparation of transforming deoxyribonucleic acid by phenol treatment. *Biochim. Biophys. Acta* **72**:619–629.
- Schleifer, K. H., and U. Fischer. 1982. Description of a new species of the genus *Staphylococcus*: *Staphylococcus carnosus*. *Int. J. Syst. Bacteriol.* **32**:153–156.
- Schleifer, K. H., R. Kilpper-Bälz, and L. A. Devriese. 1984. *Staphylococcus arlettae* sp. nov., *S. equorum* sp. nov. and *S. kloosii* sp. nov.: three new coagulase-negative, novobiocin-resistant species from animals. *Syst. Appl. Microbiol.* **5**:501–509.
- Schleifer, K. H., R. Kilpper-Bälz, U. Fischer, A. Faller, and J. Endl. 1982. Identification of “*Micrococcus candidus*” ATCC 14852 as a strain of *Staphylococcus epidermidis* and of “*Micrococcus caseolyticus*” ATCC 13548 and *Micrococcus varians* ATCC 29750 as members of a new species, *Staphylococcus caseolyticus*. *Int. J. Bacteriol.* **32**:15–20.
- Schleifer, K. H., and W. E. Kloos. 1975. Isolation and characterization of staphylococci from human skin. I. Amended descriptions of *Staphylococcus epidermidis* and *Staphylococcus saprophyticus* and descriptions of three new species: *Staphylococcus cohnii*, *Staphylococcus haemolyticus*, and *Staphylococcus xylosum*. *Int. J. Syst. Bacteriol.* **25**:50–61.
- Silvestri, L. G., and L. R. Hill. 1965. Agreement between DNA base composition and taxonomic classification of gram-positive cocci. *J. Bacteriol.* **90**:136–140.
- Tamaoka, J., Y. Katayama-Fujimura, and H. Kuraishi. 1983. Analysis of bacterial menaquinone mixtures by high performance liquid chromatography. *J. Appl. Bacteriol.* **54**:31–36.
- Tamaoka, J., and K. Komagata. 1984. Determination of DNA base composition by reverse-phase high-performance liquid chromatography. *FEMS Microbiol. Lett.* **25**:125–128.
- Tanasupawat, S. 1984. Lactic acid bacteria found in fermented tea leaves, Miang. *J. Grad. School Chulalongkorn Univ.* **5**:84–92. (In Thai.)
- Tanasupawat, S., and W. Daengsubha. 1983. *Pediococcus* species and related bacteria found in fermented foods and related materials in Thailand. *J. Gen. Appl. Microbiol.* **29**:487–506.
- Tanasupawat, S., Y. Hashimoto, T. Ezaki, M. Kozaki, and K. Komagata. 1991. Identification of *Staphylococcus carnosus* strains from fermented fish and soy sauce mash. *J. Gen. Appl. Microbiol.* **37**:479–494.
- Tanasupawat, S., and K. Komagata. 1988. DNA base composition, quinone systems, and cellular fatty acid composition of strains in *Pediococcus* species. *Bull. Jpn. Federation Culture Collect.* **4**:63–67.
- Valardo, P. E., R. Kilpper-Bälz, F. Biavasco, G. Satta, and K. H. Schleifer. 1988. *Staphylococcus delphini* sp. nov., a coagulase-positive species isolated from dolphins. *Int. J. Syst. Bacteriol.* **38**:436–439.
- Yamada, K., and K. Komagata. 1970. Taxonomic studies on coryneform bacteria. III. DNA base composition of coryneform bacteria. *J. Gen. Appl. Microbiol.* **16**:215–224.