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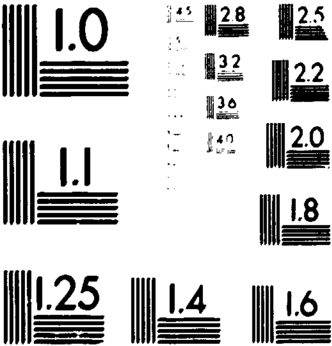

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LACTIC FERMENTATION IN TRADITIONAL FOODS OF THAILAND*

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CONTENTS

I. BACKGROUND

Thailand, being a tropical agricultural country, has a wide variety of fermentation,ranging from traditional, cottage-level production of fermented foods and feeds to large-scale industrial production for export.

Lactic fermentations in Thailand play a significant role in the country's economy and employment, and the nutrition of its people. With a few exceptions of imported technologies, most lactic fermentations are based on local, indigenous technologies. While many production processes remain traditional, some have evolved from traditional to modern, advanced processing.

Major agricultural raw materials which are readily available for lactic fermentation include fish, meat, vegetables, fruits and cereals. Most lactic fermentations involve the use of salt with or without carbohydrate sources such as starch and sugar. Unlike mold and yeast fermentation, lactic fermentations rely on natural microorganisms instead of starter cultures.

Thailand is the location of a Microbiological Resource Center for SE Asia,known as Bangkok MIRCEN,where useful microbial cultures including lactic bacteria,are maintained. Several lactic bacteria strains having special characteristics such as salt and alcohol tolerance are available for future research use in genetic improvement.

II. INTRODUCTION

Thailand, like most of the developing countries in Asia, is a country where several traditional fermentad food products are known for many decades. Many kinds of microorganisms are, of course, involved in such fermentation,including lactic fermentation.

The Thai traditional fermented foods are important elements in the diets of the majority of the people in Thailand, particularly in the rural areas of the country. These traditional fermented foods play a significant role in :

- o preserving easily perishable food, such as fruits, vegetables, meat and fish.

- o nutritional improving through the development of higher nutritional value and higher digestible products, e.g. yoghurt and yakult.

- o product development and diversification by means of new product development for better texture, flavor, and aroma.
- o sanitary quality improvement because fermentation accompanying by salt and acid will destroy pathogenic flora and other food-borne diseases normally caused by microorganisms.

Since Thailand is a developing country, most of the population have very low income, and therefore, food fermentation in the country has always been by traditional methods in small-scale and thus becomes family business. This is because it requires low investment and easier to manage than the larger scale. These fermented food products will be a good source of their additional income as well as their extra food supply.

III. PRODUCTION OF MAJOR AGRICULTURAL PRODUCTS IN THAILAND

Being an agricultural country, the country economy depends largely upon agriculture. In 1980, more than 70% of the Thai population were engaged in agricultural production. Thailand has many kinds of raw materials available, the surplus of which is readily preserved through various means including traditional food fermentation. The major agricultural products are shown in Table 1.

Table 1 : Production of major agricultural products in Thailand, 1982/83

Products	Quantity, tons	Value, million Bahts (25 Bahts = US $1)	
Rice:			
Rice	16,879,000	4,742,230.0	
Food crops:			
Maize	3,002,300	6,034.6	
Cassave roots, fresh	17,788,000	9,071.8	
Sugarcane	24,407,000	11,398.3	
Mungbean	281,300	1,659.4	
Oil Seeds:			
Soybean	113,400	688.3	
coconut	1,076,000	1,998.8	
		2,143.3	
Other crops:			
Garlic	173,400	2,608.1	
Onion & shallot	241,900	1,642.5	
Chilli	61,400		
Livestocks:			
Swines	4,022,106 heads (3,252,504 slaughtered)		(23.51 ฿/kg)
Cattles	4,578,699 heads (356,683 slaughtered)		(39.49 ฿/kg)
Buffaloes	6,417,433 heads (86,506 slaughtered)		(32.19 ฿/kg)
Fish:			
Fish (fresh water and marine)	1,920,000 tons	15,650.6	
Bamboo shoots, fresh	235 tons *	2,279,000 *	bahts
Ginger,	7,309 tons *	68,674,000 *	"
Vegetables, dried, salted	310 tons *	7,408,000 *	"
Fruits, brining	29 tons *	593,000 *	"
Crustaceans and molluscs, salted	193 tons *	8,146,000 *	"
Blachan (Shrimp paste)	106 tons *	4,396,000 *	"
Fish sauce	7,534 tons *	112,038,000 *	"
soya sauce	214 tons *	5,546,000 *	"

* Quantity and value for export only

IV. RAW MATERIALS AND PRODUCTS OF LACTIC FERMENTATIONS

The food fermentation industry in Thailand has been benefited by the use of lactic fermentation which contributes its important role in food preservation, food product development and nutrition improvement. Major raw materials for lactic fermentation and products are shown in Table 2.

Table 2: Major raw materials for lactic fermentation and its products.

	Raw materials		Scale of operation	Product	Consumption
I	Vegetables	: mixed vegetables.	Traditional & commercial	Si-sek-Chai	Local&export "
		turnips	"	Hua-chai-po	"
		onion	"	Hom-dong	"
		mushroom	"	Hed-dong	"
		fermented tea leaves	Traditional	Sai-miang	Local
II	Fruits	: mango	Traditional & commercial	Phonlamai-dong	Local & export
		papaya	"	mala-gor-dong	"
		lime	"	ma-nao-dong	"
III	Fish	: fresh water	Traditional & and commercial	Nam-pla	Local & export
		marine fish	"	pla-ra pla-chao	" Local
		etc.	"	Som-fak	"
IV	Meat	: pork	Traditional & commercial	Naem	Local
		pork or beef	"	Mu-som Sai-krok prio	" "
V	Cereals and Grains	: Rice	Traditional "	Khanom-Chin Khanom-tan	Local "
VI	Milk	: Milk	Commercial	Yoghurt Yakult	Local "

Different varieties of fermented products are products using essentially the same process. Variations are due to difference in raw materials and additives used. Some of the lactic acid bacteria involved are shown in Table 3.

Table 3: Major Lactic acid Becteria in Some Fermented Foods.

Products	Raw material	Major Lactic Acid Bacteria
Soy sauce	Soybeans	Lactobacillus delbruckii Pediococcus halophilus
Pickled fruits	Fruits	L.plantarum, L.brevis, P. cerevisiae, Leuconostoc mesenteroides
Pickled vegetables	Vegetables	L.plantarum, L.brevis, S.lactis, Pediococcus cerevisiae
Shrimp paste (Blachan)	Shrimp	L.casei var. casei , P. halophilus
Meat (Nham)	Pork	L.brevis, L.plantarum, P.cerevisiae, Pediococcus sp.
Fermented bamboo	Bamboo shoot	L.brevis, L.buchneri, L.fermenti, Leuconostoc mesenteroides P.cerevisiae
Hoi-dong	Crustaceans	P.halophilus
Pla-som	Fish	P.pentosaseus

V. LACTIC FERMENTATION PROCESSES AND RESPONSIBLE MICROORGANISMS

Most fermented foods in Thailand are generally produced through the methods of brining, marinating, sugaring, and fermenting or the combinations of these methods, i.e., salted-fermented foods, etc. These means of fermentation are simple and most convenient for the household and therefore most of these products are prepared by cottage-type operations. Some of the lactic acid fermentation processes and responsible microorganisms are shown in the following diagrams :

Tea leaves

↓

Steamed

↓

Wrapped tightly in
individual bundles

↓

Packed into containers
(small basket for young tea leaves
large underground cement wells
for mature tea leaves)

↓

Pressed tightly and weighted down

↓

Covered with banana leaves
and plastic sheet

↓

Fermented
(4 - 7 days for young tea leaves,
one year for mature tea leaves)

↓

MIANG
(Fermented tea leaves)
(Served as a snack)

Flow sheet for the production of Miang.

Fresh water fish
(*Tricbogaster tricbopterus, Notopterus notopterus, Opbicepbalus striatus, Clarias batracbus*)

↓

Scale and remove the entrails

↓

Mix with salt
in the ratio of 3:1 (w/w)

↓

Leave overnight

↓

Pack tightly in small necked
earthen jars

↓

Cover with bamboo sticks
and flood with saturated brine

↓

Incubate (15 - 90 days)

↓

Remove the fish from the jar
and mix with ground roasted rice
in the ratio of 1:10 (w/w)

↓

Repack in the jar and flood
with brine

↓

Incubate for at least 6 months

↓

PLA–RA

Flow sheet for the production of Pla-Ra.

Minced or ground fish meat
(*Ophicephalus lucius*)

↓

Add ground cooked rice,
minced garlic and salt
in the ratio of 3:1:1 (w/w)

↓

Mix thoroughly until pasty

↓

Pack tightly in a bowl and
cover with plastic sheet
(or pack separately in small
plastic bags)

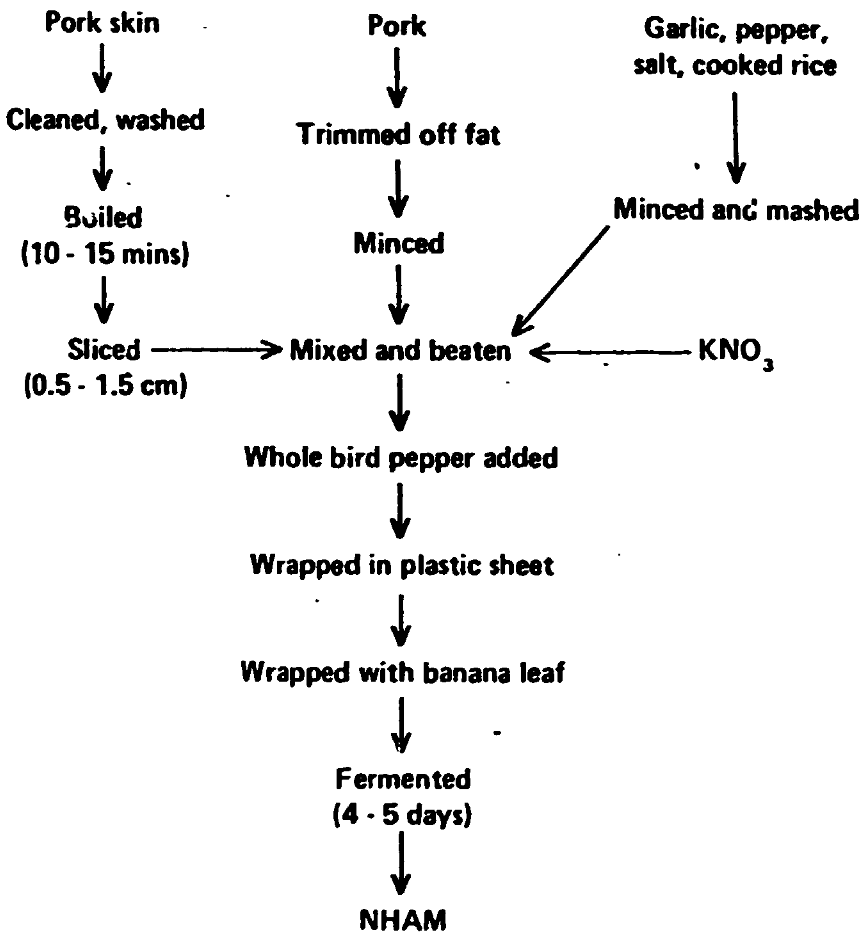
↓

Ferment
(5 - 10 days)

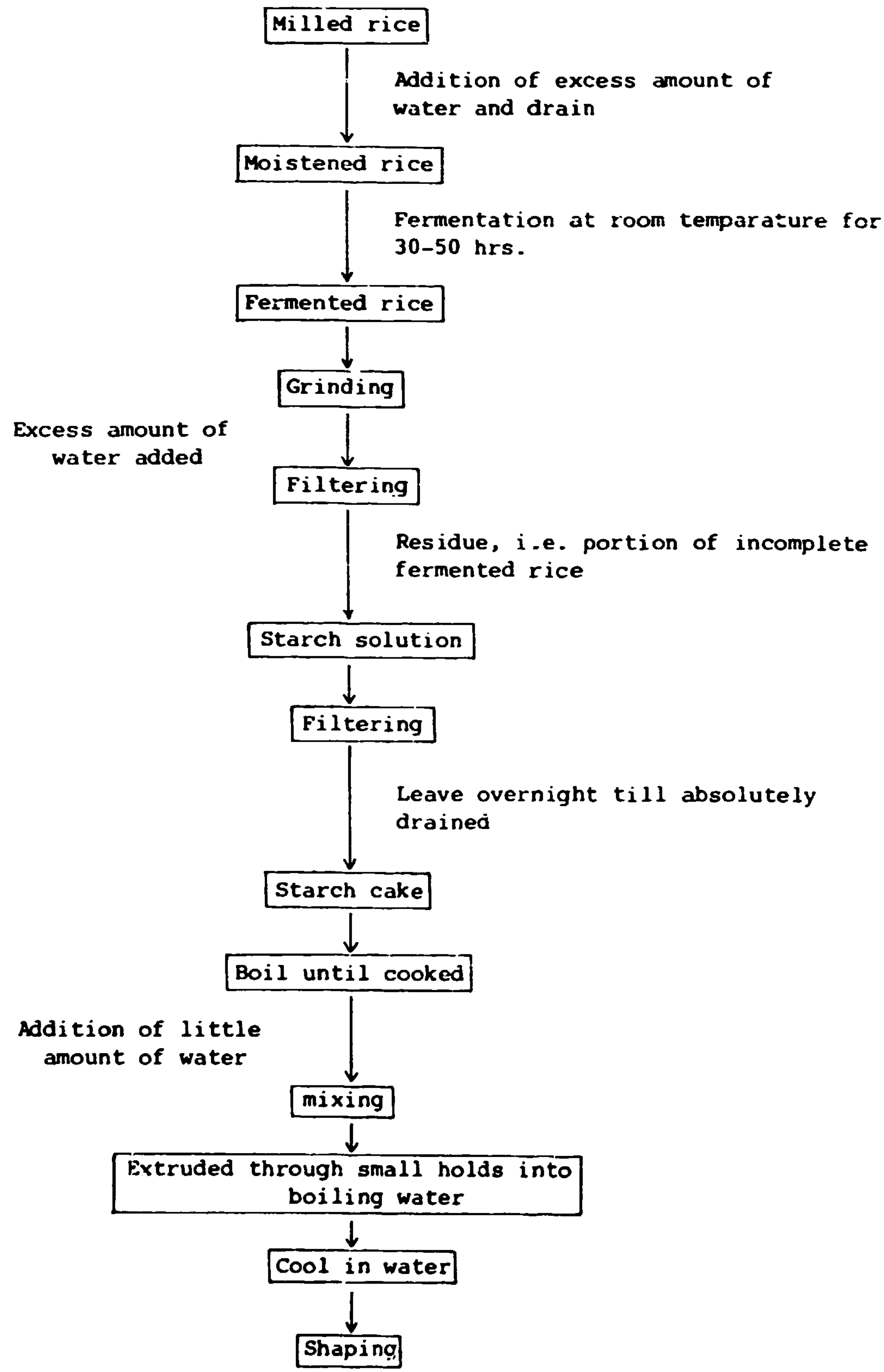
↓

SOM–FAK

Flow sheet for the production of Som-Fak



Flow sheet for Nham fermantation



The Flowsheet for the Production of Khanom-Chin from long-grain rice (*Oryza sativa* L.)

VI. COMMERCIALIZATION OF TRADITIONAL LACTIC FERMENTATIONS

The fermentation of these traditional fermented foods vary from the simplest to the most complex process but research and development of food fermentation in Thailand has been limited. In many cases, the microbial starter is carried over from fermentation to fermentation and in no case that the pure culture is used. However, at present, fermentation technology has been playing a very important part in the food industry and it has taken quite progressive steps into many kinds of commercial food production. Some traditional fermented foods at cottage-level becomes popular amongst consumers and the larger scale production has been developed. There are many factories nowadays which produce fermented products such as Nam-pla and Nham. These products are being exported.

In fact, there are certainly some advantages for the commercial scale food fermentation. The products will be of improved quality and higher nutrition value through modernized technology of production. However, there are also some disadvantages as to the higher cost of production due to expensive equipment and then less workers are required causing some social problems in the country.

According to recent survey, in 1984, the commercial fermentations in Thailand which are classified into 13 types, as shown in Table 4, are quite large in number.

Table 4: Numbers and types of fermented food factories.

Products	Number of factories
Glucose	18
Vinegar	9
Alcoholic beverages	35
Soy sauce and related products	35
Yoghurt and related products	4
Citric acid	1
Food flavoring agents	5
Yeast	1
Antibiotics	1
Nham	9
Fermented fruits and vegetables	24
Nam-pla	36

VII. BANGKOK MIRCEN AND TECHNICAL COOPERATION

MIRCENS are a world network of microbiological resource centers each emphasizing specific areas of interest, with the Bangkok MIRCEN serving in the area of fermentation, food and waste recycling. Established within the framework of UNEP/UNESCO guidelines, MIRCENS are designed :

- to promote the applications of microbiology in the strengthening of rural economics.
- to serve as focal centers for the training of manpower and the imparting of microbiological knowledge, and
- to provide the infrastructure for the building of a world network which would incorporate regional and interregional cooperating laboratories geared to the management, distribution, and utilization of the microbial gene pool.

Bangkok MIRCEN maintains a small collection of lactic acid bacteria known to be responsible for several lactic fermentations. The name list of such collection is given in Annex I. Bangkok MIRCEN could serve as a focal center for lactic fermentation training as well as a focal point for interregional cooperating laboratories wishing to exchange microbial cultures and related technical information.

Bangkok MIRCEN operates in cooperation with its affiliated laboratories in the Southeast Asian Region, namely :

- Natural Science Research Center, University of the Philippines, Philippines.
- Faculty of Mathematics and Natural Sciences, University of Indonesia, Indonesia.
- Department of Botany, National University of Singapore, Singapore.
- Microbiology Department, National University of Malaysia, Selangor, Malaysia.
- Department of Biology, Chinese University of Hong Kong, Hong Kong.
- Soil Microbiology Branch, Division of Soil Science, Department of Agriculture, Bangkhen, Bangkok, Thailand.
- Department of Microbiology, Kasetsart University, Bangkhen, Bangkok, Thailand

ANNEX I

LIST OF LACTIC ACID BACTERIA

TISTR Culture Collection

Bangkok MIRCEN

1984

Lactobacillus	***acidophilus*** (Moro)	Hansen & Mocquot
382	TUA 002	1980
450	TUA 346 L	1981
Lactobacillus	***buchneri*** (Henneberg)	Bergey et. al.
48	DMKU---ATCC 4005	1970 (5,10)
Lactobacillus	***bulgaricus*** (Orla-Jensen)	Rogosa & Hansen
451	TUA 093 L	1981
Lactobacillus	***casei*** (Orla-Jensen)	Hansen & Lessel
47	DMKU---ATCC 7469	1970
372	TUA 333---ATCC 7469	1979
389	TUA 016	1980
390	TISTR	1980 (4)
453	TUA 164 L	1981
477	MSDS--- ATCC 7469	1983
Lactobacillus	***cellobiosus***	
348	TISTR	1980 (4)
Lactobacillus	***delbrueckii*** (Leichmann)	Beijerinck
108	NRRL B-445	1976
326	UPCC 77	1977
Lactobacillus	***fermentum*** Beijerinck	
55	DMKU---ATCC 14931	1970 (5,10)
391	TISTR	1980 (4)
Lactobacillus	***lactis*** (Orla-Jensen)	Bergey et. al.
452	TUA 026 L	1981
Lactobacillus	***leichmanii*** (Henneberg)	Bergey et. al.
449	UQM 1364	1981
476	MSDS---ATCC 7830	1983

Lactobacillus	***plantarum*** (Orla-Jensen)	Bergey et. al.
50	DMKU---ATCC 8041	1970 (5,10)
373	TUA 354---ATCC 8041	1979
475	MSDS---ATCC 8014	1983
Lactobacillus	***vaccine***	
460	TUA X90	1981
Leuconostoc	***citrovorum***	
455	TUA 165 L	1981
Leuconostoc	***dextranicum*** (Beijerinck)	Hucker and Pederson
56	DMKU---ATCC 19255	1970 (5,10)
377	TUA 204 (P-S)---IFO 3349	1979
454	TUA 204 L	1981
474	DMKU 8M8/25 B	1982
Leuconostoc	***mesenteroides*** (Cienkowski)	van Tieghem
53	DMKU---ATCC 10830	1970 (5,10)
120	UPCC 44	1976
473	DMKU 8M8/25 A	1982
478	MSDS---ATCC 8042	1983
Pediococcus	***acidilactici*** Lindner	
397	NISL 7113	1980
424	DMKU N53	1981 (14,15)
425	DMKU N54	1981 (14,15)
Pediococcus	***acidophilus***	
375	IFO 3205---AHU 1123	1979
Pediococcus	***cerevisiae*** Balcke	
51	DMKU---ATCC 8042	1970
335	UQM 786	1977

Pediococcus *halophilus* Mees

332	DMKU B119	1977 (11)
333	DMKU B120	1977 (11)
334	DMKU B121	1977 (11)
429	DMKU Ph01	1981 (6,14,15)
430	DMKU Ph25	1981 (6,14,15)
431	DMKU Ph27	1981 (14,15,16)
432	DMKU Ph45	1981 (14,15)
433	DMKU Ph47	1981 (3,14,15)
434	DMKU Ph59	1981 (3,14,15)
435	DMKU Ph65	1981 (14,15,16)
436	DMKU Ph88	1981 (1,14,15)
437	DMKU Ph120	1981 (9,14,15)
438	DMKU Ph130	1981 (9,14,15)
439	DMKU Ph155	1981 (14,15,16)

Pediococcus *pentosaseus* Mees

374	TUA P-19---IFO 3891	1979
413	DMKU N01	1981 (14,15)
414	DMKU N31	1981 (14,15,16)
415	DMKU N37	1981 (14,15)
416	DMKU N38	1981 (14,15)
417	DMKU N78	1981 (14,15)
418	DMKU N91	1981 (14,15)
419	DMKU N133	1981 (14,15)
420	DMKU N256	1981 (14,15)
421	DMKU N271	1981 (14,15,16)
422	DMKU N278	1981 (14,15)
423	DMKU N295	1981 (14,15,16)

Pediococcus sp:

129	TISTR	1977

Pediococcus *soyae* Sakaguchi

72	IAM 1688---ATCC 13624 ---NISL NO. 7153	1972

Pediococcus *urine-equi*

394	IAM 1684	1980
426	DMKU N86	1981 (14,15)
427	DMKU N01	1981 (14,15)

Streptococcus *cremoris* Orla-Jensen

58	TISTR	1970
456	TUA 439L	1981

Streptococcus	*faecalis* Andrewes and Horder	
379	TUA 369---ATCC 19433	1979
459	TUA 194L	1981
Streptococcus	*lactis* (Lister) Lohnis	
457	TUA 154L	1981
Streptococcus	*lique*	
378	TUA 156 (4-15)	1979
Streptococcus	*thermophilus* Orla-Jensen	
59	TISTR	1970
458	TUA 196L	1981

BIBLIOGRAPHY ON LACTIC ACID BACTERIA IN THAILAND

1. Amorntiparat, M. 1979. A Microbiological Study on Thai Traditional Fermented Food Product : Budu. M.S. Thesis, Department of Microbiology, Kasetsart University, Bangkok, Thailand

2. Appleton, J.M.; V.F. McGowan and V.B.D. Skerman. 1980.Microorganisms and Man. World Data Center (MIRCEN). Department of Microbiology, University of Queensland, Brisbane, Australia

3. Artjariyasripong, S. 1979. A Microbiological Study on Thai Traditional Fermented Food Products: Kung-Chom and Hoi-Malangpu-dong. M.S. Thesis, Department of Microbiology, Kasetsart University. Bangkok, Thailand

4. Daengsubha, W; T. Toyota; S. Okada and M.Kozaki 1980. Taxonomic Study of Some Lactic Acid Bacteria Isolated from Bagasses in Thailand. Annual Reports of International Center of Cooperative Research and Development in Microbial Engineering Vol. 3, 1980. Faculty of Engineering, Osaka University, Osaka, Japan.

5. Dhavises, G. 1972. Microbial Studies during the Pickles of the Shoot of Bamboo, Bambusa arundinacea, and of Pak-Sian, Gynandropsis pentaphylla. M.S. Thesis, Department of Biology, Kasetsart University, Bangkok, Thailand.

6. Hongthongdaeng, P. 1979. Microbiological Study on Thai Traditional Fermented Food Product: Pla-ra. M.S. Thesis, Department of Microbiology, Kasetsart University, Bangkok. Thailand

7. Inoue, Y.; M. Takano and I. Shibaski. 1980. Antagonistic Action of Lactic Acid Bacteria fram Nham toward Food-Deteriorating Bacteria. Microbial Utilization of Renewable Resources Vol. 1, 1980. Faculty of Engineering, Osaka University, Osaka Japan.

8. Lolong, N. 1978. Soy souce Production in Thailand, Paper submitted at ASEAN-Australian seminar on soy sauce held at Singapore. January 22-24, 1978.

9. Neetiwatanapong, Ch. 1979. A Microbiological Study on the Thai Traditional Fermented Food Products : Tai-pla, and Pla-paeng-daeng. M.S. Thesis, Department of Microbiology, Kasetsart University, Thailand.

10. Steinkraus, K.H. 1983. Handbook of Indigenous Fermented Foods. Marcel Dekker, Inc. New york and Basel.

11. Suknaisilp, S. 1977. A Study on Lacteria in the Fermentation of Thai Soy Sauce. M.S. Thesis, Department of Microbiology, Kasetsart University, Bangkok, Thailand.

12. Sundhagul, M., W. Daengsubha and P. Suyanandana. 1975 Thailand's Traditional Fermented Food Products : A brief description. Thai. J. Agri. Sci. 8:205-219.

13. Takada, N.; T. Iwashiro; J. yagyu; A. Bhumiratana T. Flegel and Y. Oshima. 1980. Microflora in various Thai fermented foods. Microbial Utilization of Renewable Resources Vol. 1 1980, Faculty of Engineering, Osaka University,Osaka, Japan.

14. Tanasupawat, S. 1981. A Taxonomic Study of Tetrad-grouping bacteria. M.S. Thesis, Department of Microbiology, Kasetsart University, Bangkok, Thailand.

15. Tanasupawat, W. and Wiwat Daengsubha. 1983. Pediococcus species and related bacteria found in fermented foods and related material in Thailand. J. Gen. Appl. Microbiol., 29, 487-506.

16. Visawawong, N. 1979. A Microbiological Study on the Thai Traditional Fermented Food Products : Pla-Chao, Pla-som and Som-fug. M.S. Thesis, Department of Microbiology, Kasetsart University, Bangkok, Thailand.

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