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# ESTABLISHMENT OF AN INTERNATIONAL LACTIC ACID FERMENTATION TECHNOLOGY NETWORK (LABNET)

by

K. KOMAGATA

# ESTABLISHMENT OF AN INTERNATIONAL LACTIC ACID FERMENTATION TECHNOLOGY NETWORK [LABNet]

We are all aware of the fact that biotechnology and genetic engineering can have a unique potential to improve disadvantaged populations. However, a technology assessment is often very difficult since the socio-economic environment can have a profound impact on its success. When the focus is on profits and efficiency, results of technology assessment will be quite different from the one that will emerge if the focus is on sustainable development and employment generation. The reason for this problem lies mainly with the economist, who at present is able to evaluate an industry *defined* by

products but has great difficulties with an industry which is a *means* of production.

In recent years, the achievements of modern biotechnology and genetic engineering have been associated with a rapid growth of networks in bioinformatics, and they are now becoming extremely popular in the developed world. So far, however, the emphasis was restricted mainly to new drugs and improved seeds for the major food crops. The synergistic potential between communication technology and modern biotechnology in the agroindustrial area has only recently started and was pioneered by the Biofocus Foundation, which underlined the potential of genetic engineering for the upgrading of traditional technologies by means of an improvement management of microbial starter cultures.

Lactic acid bacteria have been chosen initially because of their importance for the manufacture of fermented foods and dairy products as well as their impact on health care all over the world. Initially it is vital to concentrate on the importance of starter cultures on fermented dairy products.

Milk is the normal habitat of a number of lactic acid bacteria which may cause spontaneous souring. For a sophisticated control, however, modern industrial processes utilize specially prepared lactic acid bacteria as starter cultures in the manufacture of fermented dairy products. A starter usually consists of

harmless microorganisms which, upon culturing in milk or milk-based mixes, impart desirable and predictable characteristics of flavour and texture attributable to a certain fermented milk product. A multi-strain starter is considered to have an advantage over a single strain starter since fermentation will continue in the presence of a phage which specifically attacks one strain only. In Australia and New Zealand, the preferred technology is to grow two single starters individually and to mix them prior to culturing of cheese vats. The advantage of this technique is that an individual strain, preselected for its performance and resistance to antibiotics and phages, is used for ensuring greater predictability and uniformity of culture effects. A wealth of information on the starter cultures in dairy products is available now in the literature.

For the distribution of starters an earlier method involved shipping them as a liquid culture containing about $10^9$ organisms/ml. However, subculturing caused loss of critical characteristics. Presently, the most common method for distribution is in the form of frozen concentrates containing approximately $10^{11}$ organisms/ml. The culture concentrates are standardized for activity by the culture manufacturer and has eliminated the need for routine maintenance at a plant level. The starters are graded according to their acid production, rate of growth, phage and antibiotic resistance, and ability to develop

typical flavour and texture.

The production of lactic acid, acetic acid, $CO_2$, diacetyl and acetaldehyde from lactose and citric acid is of fundamental importance to the growth of lactic cultures and generation of characteristic flavour in products. The fermentation reactions are carried out by homo- and heterofermentative systems. Furthermore, improvements in the desired product formation can easily be achieved through genetic modification.

The starter is therefore the most crucial component, and it is essential to develop and maintain appropriate microbiological expertise in the propagation, maintenance, and control of lactic starter cultures. Culture propagation should neverthless still be conducted in a specified, secluded area of the plant where access of personnel is restricted. Airborne contamination and phage infection must be controlled.

Control of acid and flavour development in lactic acid starters cultures may be achieved by understanding their growth characteristics. By modifying the inoculation rate, incubation temperature, and time, it is possible to direct the fermentation, in a limited way, to fit the plant schedules.

In short, the microbiological activities of starter cultures should control the growth of spoilage bacteria and pathogens. Latest developments in microbial process development has shown that the success of most microbial

technologies hinges on the state and condition of the starter culture or inoculum.

Lactic acid bacteria starter cultures are, however, not only used in dairy products, but are more important, i.e. in Southeast Asia in fermented foods, fermented beverages, vegetable fermentations, fodder preparations (silage), and the utilization of agricultural wastes, manure, slaughterhouse waste and fishery waste.

Furthermore, lactic acid bacteria play a very significant role in human intestinal flora and thus exhibit a number of health effects.

Against this background of the vast potential of lactic acid bacteria to influence the life-quality in developing countries, a natural setting for a research and development effort ought to be given high priority.

Mutation and the various mechanisms for DNA transfer have undoubtedly resulted in a reservoir of naturally occurring strains of lactic streptococci which vary considerably in genotype. There has also been recently much speculation about genetical engineering of starter cultures. The first concern must be to provide a starter culture that is resistant to phage and still has a high rate of acid production. Little is known, however, about the basic biology of phage resistance in lactic acid bacteria.

It is only in the last couple of years that the full potential of lactic acid bacteria has started to be fully

realized in the form of isolated genes, plasmid vectors, chromosomal vectors, chromosomal integration vectors and I have just heard a few genetical approaches at the 9th International Biotechnology Symposium in Washington in August this year. These presentations, however, were mainly concerned with modifications of the carbohydrate metabolism to enhance flavour production.

For the practical applications of genetic engineering, metabolic stability, 'food-grade' genetic systems and phage resistance are all important goals.

The overall goal therefore of the global network is to strengthen the local scientific and technological capabilities in developing countries and to do this in a network fashion, where members in poor countries are supported by their colleagues in the industrialized world. The network would be designed to facilitate international cooperation where the members from developing countries can identify their needs and solve their own problems.

It is proposed to develop a non-profit but self-supporting international network on fermentations by lactic acid bacteria over a five year period. The aims is a decentralized structure designed to achieve an action-oriented synergistic interaction between specialised activities, largely based on established laboratory networks. LABNet would have four major functions:

1. the screening for methods, strains and applications that will be of special significance to developing countries;
2. open information exchange on research activities related to the impact of lactic acid bacteria on health and nutrition in man and animals, on food technology and on the upgrading of agricultural residues and of fish- and slaughterhouse wastes;
3. management of expert task forces set up to achieve specific results;
4. support of entrepreneural activities and indigenous creativity in the lactic acid bacteria field.

It is visualized that the international network will be organized from a combination of small face-to-face meetings and computer-assisted conferences. Action-oriented' working groups and innovative 'task forces' will communicate via computer conferences with the help of expert moderators. The overall project will be coordinated by a project manager with a small staff supplemented with fellowship workers being trained in communication technology, data base use and starter culture management.

In order to avoid 'duplication' and 'reinventing the wheel', LABNet will seek in the long-term close cooperation with existing international organizations and partnerships with scientific organizations, especially MIRCENS.

For the launching of LABNet it is important that its aims, approaches and progress are made widely known through partners that can act as information channels, for example existing networks such as the various information networks.

## Bangkok MIRCEN

*REVIEW: CURRENT STATE*

### Scope of the Bangkok MIRCEN

The Microbiological Resources Center for the Southeast Asia (Bangkok MIRCEN) was established in 1976 at the Thailand Institute of Scientific and Technological Research (TISTR), Bangkok, Thailand. The first major task of Bangkok MIRCEN was to identify areas of activities of regional economic development where microorganisms play key roles. A survey was made on culture resources in collections in Thailand and in other ASEAN member countries, namely, Indonesia, Malaysia, Philippines, and Singapore. It was found from this survey that the R & D activities were more or less confined to food fermentation and other industrial fermentation. Technical information related to cultures, particularly their potential utilization, was lacking, and information exchanges in this field were limited to personal communications.

Bangkok MIRCEN serves the microbiological community of the region with the following functions:

1) Collection, preservation, characterization, and distribution of microorganisms --bacteria and fungi including yeasts-- important for biotechnology, education, and applied

research.

2) Collection and dissemination of information relevant to the cultures and their application.

3) Promotion of research activities directed towards the needs of the origin.

4) Training of manpower and fellowship program.

5) Acting as a liaison.

## Financial, Personnel, and Facilities Supports

Financial supports for Bangkok MIRCEN has largely been contributed by the Government of Thailand, through TISTR, in the form of technical personnel, research funds, and other supporting facilities. Contribution of the Government of Thailand is approximately accounted for US$ 95,000 a year. One director, three full-time persons, two part-time persons, and a technician, and the personnel expenses are provided by TISTR. They are dealing with management and service business on the collection and the maintenance of the microbial cultures. Additional funds have been provided by UNESCO, UNEP, ASM, and other sources. Major necessary equipment, chemicals, electricity, gas, and water supply are provided by TISTR.

## Culture Collection Activities

Bangkck MIRCEN maintains a collection of microorganisms important for agriculture and industry. It has approximately

2,500 strains of bacteria, yeasts, molds, and algae in 1991. A majority of these microorganisms are preserved in freeze-dried form.

Since Bangkok MIRCEN started the operation, it has distributed approximately 4,500 cultures to universities and research institutions within Thailand and approximately 400 cultures to other countries. Attempts have also been made to acquire economically important cultures from collections in the region for deposition at Bangkok MIRCEN. During its 16-year operation, approximately 1,700 cultures have been obtained from several institutions of different countries.

Catalogues of holdings of Bangkok MIRCEN have been prepared in 1975, 1979, 1985, 1987, and 1990, and a catalogue of the 4th edition contains over 1,300 strains of bacteria, yeasts, molds, and algae. Bangkok MIRCEN has prepared lists of cultures and other publications relevant to culture collections and biotechnology, and these publications have been widely distributed.

Bangkok MIRCEN has been responsible for the assembly of information on microbiological institutions in the Southeast Asian region and data on collections of microorganisms, and Thailand Directory of Collections of Cultures of Microorganisms was published in 1988, and the microbial data are stored by the use of dBASE III plus.

Co-operating Laboratories

Bangkok MIRCEN has, at present, 4 co-operating laboratories in Hong Kong, Indonesia, Malaysia, and Philippines. These laboratories interact with Bangkok MIRCEN in the promotion of MIRCEN activities at the national level and cooperate in dissemination of information. Bangkok MIRCEN helps strengthen their roles by providing technical assistance especially in the field of culture collections, funding for maintenance of culture collections and research grants. Bangkok MIRCEN maintains close links with its co-operating laboratories.

**Workshop and Training Courses**

Regional workshops and trainings in the field of applied microbiology including culture collections have been one of the main activities of Bangkok MIRCEN. These workshops and training courses have been organized periodically at national and as well as regional levels. The ultimate objective of the training activities is to strengthen regional and local capabilities in the development and maintenance of culture collections. In addition, an intensive on-the-job training on culture collections has been provided on request. A total of 666 trainees have participated in the training program. Of this number, 21 trainees were from China, Hong Kong, Indonesia, Laos, Malaysia, Pakistan, Philippines, Trinidad, and UK.

### Research Grant

Research grants within the framework of the MIRCEN program have been available for Bangkok MIRCEN to disburse on behalf of the MIRCEN to collaborating laboratories and researchers of the region.

### Research Activity

Bangkok MIRCEN has been actively engaged in research activities in the areas of the MIRCEN framework. Funds have been made available for foreign scientists and professors to carry out joint cooperative research programs at the Bangkok MIRCEN and *vice versa*. A program aiming at upgrading efficiency and widening the scope of usefulness of microorganisms for industrial and agricultural applications is also carried out. The work includes the isolation and testing of new strains as well as strains in Bangkok MIRCEN Culture Collection.

### Regional and International Collaboration

Bangkok MIRCEN has collaborated with several regional and international bodies by participating in and contributing to regional and international workshops, training courses, meetings, conferences, and other activities.

### Promotional Activities

A number of short articles on Bangkok MIRCEN and its ac-

tivities (in Thai and English) have been regularly published in several science journals for the purpose of familiarizing scientists and students to become aware of the beneficial roles of microorganisms and the information of the source on the subject. Bangkok MIRCEN has also issued newsletters and other useful publications for distribution to other MIRCENs, educational and research institutions within Thailand and abroad.

***ASSESSMENT***

Bangkok MIRCEN has contributed through activities of its culture collection and research in enhancing TISTR 's visibility and competence in the fields of applied and environmental microbiology and biotechnology. Bangkok MIRCEN Culture Collection is a medium-sized collection, and manpower and equipment are not fully satisfied. However, Bangkok MIRCEN Culture Collection has maintained approximately 2,500 microbial strains, and these strains are rather well-documented by the use of personal computers. Approximately 4,500 strains have been distributed to universities, institutions, and commercial firms not only in Thailand but also foreign countries. Speciality of Bangkok MIRCEN Culture Collection is its holdings of microbial strains, namely, cultures in this collection are consisted

of isolates from sources in Thailand, and the collection is not a copy of other culture collections. Particularly, algal collection is unique because a small number collections are maintaining algal strains in the world.

Bangkok MIRCEN has been serving as a key organization in the fields of applied and environmental microbiology and biotechnology in the Southeast Asian region, and conducting a lot of cooperating research projects with Thai researchers and with those in neighboring countries. This cooperation is useful for technology transfer and exchange of information. The development of technology is now being transferred to rural community in Thailand. In connection with the cooperation, Bangkok MIRCEN has been conducting a lot of workshops, training courses, and on-the-job trainings relevant to culture collections and biotechnology. Trainees jointed in these meetings are accounted for 666, and they have come from Thailand and foreign countries. This organization for such meetings should be highly evaluated for development of applied and environmental microbiology and biotechnology in the Southeast Asian region.

## LIST OF MIRCEN DIRECTORS

Professor J.K. Arap KETER Rhizobium MIRCEN, Department of Soil Sciences and Botany, University of Nairobi, P.O.Box 30197, Nairobi, Kenya.

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Professor S.T. CHANG, Bioconversion Technology MIRCEN, Department of Applied Biology, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong.

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* Participants: Université de Technologie (Compiègne), INSBANA (Dijon), Centre d'Immunologie INSERM-CNRS (Marseille), Laboratoire de Chimie bactérienne CNRS (Marseille), INRA (Montpellier), Institut Pasteur (Paris), INSA (Toulouse).

# THAILAND'S LABNET NODE

# UNIDO'S INTERNATIONAL LABNET NETWORK

A Proposed Resource List

by

K. Komagata

# THAILAND'S LACTIC ACID BACTERIA COLLECTION

# AT BANGKOK MIRCEN

Microbiological Service Unit

National Center of Genetic Engineering for Biotechnology

at

Thailand Institute of Scientific and Technological Research

Bangkok Thailand

1994

Microbiological Resources Center (Bangkok MIRCEN)

Thailand Institute o. Scientific and

Technological Research (TISTR)

STAFF MEMBERS

| | | |
|---|---|---|
| Director | | Poonsook Atthasampunna |
| Curators | Algae | Pongtep Antarikanonda |
| | Bacteria | Wanchern Potacharoen |
| | Fungi | Suparp Artjariyasripong |
| | Yeasts | Paipan Budhaka |
| Assistants | | Lawan Chatanon |
| | | Prasong Boonsong |
| Research Scientists | | Praphaisri Somchai |
| | | Puangpen Suyanandana |
| | | Jiraporn Sukhumavasi |
| | | Vullapa Arunpairojana |
| | | Suntud Sirianantapaiboon |
| | | Bundit Fungsin |

Culture collection of lactic acid bacteria in Thailand at the Bangkok MIRCEN began few years ago under the research project on isolation and screening of microorganisms play important role in fermented food products. There are two types of cultures in the coolection. One is the reference strains and another is the local isolates. Cultures are preserved by freeze-dired method in which regular viability check are carried out in the quality control of cultures. Number of total strains held in the collection at prestent is 156 strains of which is 50 working reference strains and 106 local isolates. Most of reference strains have been obtained from Japan and ATCC.

The cultures are distributed on request with free charge on the exchange basis and minimal charge for the governmental officers or students. The regular charge is for the private company and foreign country. The culture fee are:

250 Bath for governmental officers and students

500 Bath for private company

25 US$ for the foreign country

The collection accepts deposition of cultures of known genus and species with emphasis to the specific characters which are important in education , research or industry. The deposition fee is free for the non-restricted cultures but charge for the restricted one at a variable rate set up at each condition.

The cultures are listed alphabetically in the first part of the catalogue and numerically in the second one. The sequence of the data supplied is:

1. Scientific names of the species arranged in alphabetical order, followed by authorities for the scientific names.
2. TISTR accession number, followed by equivalent designation in other collections and/or by the name and strain designation of the isolator.
3. History of the strain or name of the depositor.
4. Source of the isolate.
5. Special applications of the strain, when known, are listed together with a reference number in brackets.

## ABBREVIATIONS

| | |
|---|---|
| ATCC | American Type Culture Collection, Rockville, Maryland, U.S.A. |
| DMKU | Department of Microbiology, Faculty of Science, Kasetsart University, Bangkok, Thailand. |
| DSM | Deutsche Sammlung von Mikroorganismen, Gottingen, Germany. |
| IAM | Institute of Applied Microbiology, University of Tokyo, Japan. |
| JCM | Japan Collection of Microorganisms, RIKEN, Wako, Saitama, Japan. |
| MSDS | Microbiology Section, Department of Science Energy, Bangkok, Thailand. |
| NISL | Noda Industrial Science Laboratory, Noda, Japan. |
| NIST | National Institute of Science and Technology, Manila, Philippines. |
| NRIC | NODAI Research Institute Culture Collection, Tokyo University of Agriculture, Tokyo, Japan. |
| NRRL | Northern Utilization Research and Development Division, U.S. Department of Agriculture, Peoria, Illinois, U.S.A. |
| TUA | Department of Agricultural Chemistry, Tokyo University of Agriculture, Tokyo, Japan |
| UPPC | University of the Phillippines Culture Collection, Diliman, Quezon City, Phillipines. |
| UQM | Microbiology Department, University of Queensland, Brisbane, Australia. |

# List of Lactic Acid Bacteria

***Lactobacillus acidophilus*** (Moro) Hansen & Mocquot

388 M.Kozaki <-TUA 002
Homofermentative
Lactic acid produced 95.83 % [01]

450 M.Kozaki <-TUA 346L

***Lactobacillus brevis***

855 S. Tanasupawat A314 [02]
=NRIC 0130
SOURCE : Fermented fish spawn (*Kai-pla dong*)

860 S. Tanasupawat P46-1 [02]
=NRIC 0134
SOURCE : Pickled bastard mustard (*Pak-sian dong*)

868 S. Tanasupawat P28-3 [02]
=NRIC 0137
SOURCE : Fermented bamboo shoot (*Naw-mai dong*)

***Lactobacillus buchneri*** (Henneberg) Bergey et al.

048 DMKU <-B.Yongsmith <-ATCC 4005
=ATCC 4005
SOURCE : Tomato pulp

***Lactobacillus bulgaricus*** (Orla-Jensen) Rogosa & Hansen

451 M.Kozaki <-TUA 093L

***Lactobacillus casei*** (Orla-Jensen) Rogosa & Hansen

389 M.Kozaki <-TUA 016
Homofermentative
Lactic acid produced 91.06 % [01]

390 Bagasses
SOURCE : Bagasses
Homofermentative
Lactic acid produced 90.90 %

453 M.Kozaki <-TUA 164L

***Lactobacillus casei subsp. rhamnosus*** Rogosa et al.

047 DMKU <-B.Yongsmith <-ATCC 7469 [03]
=ATCC 7469
Type strain
Assay of riboflavin

372 M.Kozaki <-TUA 333

***Lactobacillus cellobiosus*** Rogosa et al.

398 W. Daengsubha 7 [01]
SOURCE : Bagasses
Heterofermentative
Lactic acid produced 40.45 %
Grow at 45 C

***Lactobacillus confusus***

881 S. Tanasupawat (P322-1) [03]
=NRIC 0130
SOURCE : Rice wine (*Satoh-dong*)

934 S. Tanasupawat <-NRIC 1544
=NRIC 1544 =ATCC 27646 [02 ;03]
SOURCE : Lettuce leaves

***Lactobacillus curvatus***

938 S. Tanasupawat
=NRIC 1052 =ATCC 25601
SOURCE : Milk
%G+C 42.9

***Lactobacillus delbrueckii*** (Leichmann) Beijerinck

108 pl. pathology res. dept. <-NRRL B-445
Homofermentative
Lactic acid produced 87.35 % [01]

326 UPCC 77 <-NIST
=NRRL B-763

***Lactobacillus delbrueckii subsp. lactis*** (Orla-Jensen) Weiss et al.

785 DMKU <-ATCC 7830 [03]
=ATCC 7830
Assay of cobalamin

***Lactobacillus fermentum*** Beijerinck

055 DMKU <-ATCC 14931 [03]
=ATCC 14931
SOURCE : Fermented beets
Neotype

391 W. Daengsubha 1 [01]
SOURCE : Bagasses
Heterofermentative
Lactic acid produced 41.79 %
Grow at 45 C

683 ATCC 9338 [03]
Assay of amino acids

879 S. Tanasupawat (P1-35) [02]
=NRIC 0132
SOURCE : Pickled black mustard (*Pak-gard dong*)

914 S. Tanasupawat F10-2 [02]
=NRIC 0135
SOURCE : Fermented bean sprout (*Tua-ngok dong*)

915 S. Tanasupawat FN12-1 [02]
=NRIC 0129
SOURCE : Fermented fish (*Pla-chao*)

937 S. Tanasupawat F26-1
SOURCE : Fermented fish (*Pla-som*)
%G+C 51.4

945 S. Tanasupawat KM7-1
SOURCE : Fermented rice noodle (*Khanom-jeen*)

946 S. Tanasupawat KM17-1
SOURCE : Sour pork sausage (*Sai-krok prieo*)

947 S. Tanasupawat KM26-1
SOURCE : Fermented rice flour (*Khanom-jeen*)

948 S. Tanasupawat KM27
SOURCE : Fermented rice flour (*Khanom-jeen*)

949 S. Tanasupawat KM12
SOURCE : Pickled bastard mustard (*Pak-sian dong*)

950 S. Tanasupawat KM24-1
SOURCE : Fermented rice flour (*Khanom-jeen*)

***Lactobacillus halotolerans***

939 Sausage [03]
=DSM 20190 ;ATCC 35410
Type strain
%G+C 44.8

***Lactobacillus lactis*** (Orla-Jensen) Bergey et al.

452 M.Kozaki <-TUA 026L

***Lactobacillus leichmannii*** (Henneberg) Bergey et al.

449 UQM 1364

476 MSDS <-ATCC 7830 [*Lactobacillus delbrueckii*]
Assay of vitamin B12
%G+C 50.5

***Lactobacillus mali***

919 S. Tanasupawat <-NRIC 1076T
=ATCC 27053
SOURCE : Apple juice, Cider press [03]
Type strain

***Lactobacillus pentosus***

845 S. Tanasupawat (A35)
=NRIC 1827
SOURCE : Sour pork sausage (*Sai-krok prieo*)
%G+C 46

847 S. Tanasupawat FN2
SOURCE : Fermented fish (*Pla-som*)
%G+C 47

848 S. Tanasupawat FN4
SOURCE : Fermented pork (*Nham*)
%G+C 45

849 S. Tanasupawat FN35
SOURCE : Fermented pork (*Nham*)

851 S. Tanasupawat F36-1
SOURCE : Fermented fish (*Pla-som*)
%G+C 45

852 S. Tanasupawat F37-2
SOURCE : Fermented fish (*Pla-som*)

853 S. Tanasupawat F31-5
=JCM 8333
SOURCE : Fish cake (*Som-fak*)
%G+C 46

856 S. Tanasupawat A83
SOURCE : Fermented fish (*Pla-som*)

857 S. Tanasupawat P7-1
=NRIC 1831 ;JCM 8336
SOURCE : Pickled black mustard (*Pak-gard dong*)
%G+C 45

859 S. Tanasupawat P24-1
SOURCE : Pickled bastard mustard (*Pak-sian dong*)
%G+C 46

865 S. Tanasupawat F5-1S
SOURCE : Pickled onion (*Hom-dong*)
%G+C 47

867 S. Tanasupawat F21-1
=JCM 8337
SOURCE : Fermented bamboo shoot (*Naw-mai dong*)
%G+C 45

869 S. Tanasupawat F32-1
SOURCE : Fermented bamboo shoot (*Naw-mai dong*)
%G+C 47

870 S. Tanasupawat A330
=NRIC 1836
SOURCE : Spoiled durian
%G+C 46

871 S. Tanasupawat FP2-1
SOURCE : Fermented tea leaves (*Miang*)
%G+C 15

872 S. Tanasupawat FP18
SOURCE : Fermented tea leaves (*Miang*)
%G+C 47

873 S. Tanasupawat FP38-1
SOURCE : Fermented tea leaves (*Miang*)

874 S. Tanasupawat FP46-2
SOURCE : Fermented tea leaves (*Miang*)
%G+C 47

878 S. Tanasupawat SM01
=NRIC 1839
SOURCE : Fish cake (*Som-fak*)

880 S. Tanasupawat F11-1
SOURCE : Pickled bastard mustard (*Pak-sian dong*)
%G+C 46

920 S. Tanasupawat
=NRIC 1069T <-ATCC 8041
SOURCE : Corn Silage
Type strain
%G+C 46

940 S. Tanasupawat A1
=NRIC 1551
SOURCE : Fermented tea leaves (*Miang*)

941 S. Tanasupawat A4
=NRIC 1552
SOURCE : Fermented tea leaves (*Miang*)

***Lactobacillus plantarum*** (Orla-Jensen) Bergey et al.

050 DMKU <-ATCC 8014
Assay of amino acids
%G+C 45.1

373 M.Kozaki <-TUA 354
Requirement for pantothenic acid

541 DMKU <-P.Srisomwong L1
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 15 C ,45 C

542 DMKU <-P. Srisomwong L9
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 15 C ,45C

543 DMKU <-P.Srisomwong L33
SOURCE : Fermented pork (*Nham*)
Strong acid production
Grow at 45 C

544 DMKU <-P. Srisomwong L35
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 15 C ,45 C

844 S. Tanasupawat F7-1
=JCM 8341
SOURCE : Sour pork sausage (*Sai-krok prieo*)
%G+C 44

846 S. Tanasupawat F33-1
SOURCE : Sour beef sausage [Mum]
%G+C 43

850 S. Tanasupawat FP48-1
=NRIC 1829
SOURCE : Sour beef sausage [Mum]
%G+C 44

854 S. Tanasupawat F35-1
SOURCE : Fermented fish (*Som-fak*)
%G+C 45

858 S. Tanasupawat P16
SOURCE : (*Pak-nam dong*)
%G+C 44

861 S. Tanasupawat P30-1
=NRIC 1832 =JCM 8344
SOURCE : (*Pak-koom dong*)
%G+C 44

862 S. Tanasupawat F10-1
=JCM 8346
SOURCE : Pickled bean sprouts (*Tau-ngok dong*)
%G+C 44

863 S. Tanasupawat P17
SOURCE : Sauerkraut
%G+C 43

864 S. Tanasupawat F2-1
SOURCE : Pickled onion (*Hom-dong*)
%G+C 45

926 S. Tanasupawat KM1-1
SOURCE : Sweeted rice (*Khao-mak*)
%G+C 44

951 S. Tanasupawat
SOURCE : Fermented rice flour (*Khanom-jeen*)

***Lactobacillus sake***

890 S. Tanasupawat FN1-4
=NRIC 0125
SOURCE : Fermented pork (*Nham*)

911 S. Tanasupawat F3-1
=NRIC 0126
SOURCE : Fermented pork (*Nham*)

912 S. Tanasupawat
=NRIC 0128
SOURCE : Fermented fish (*Som-fak*)

***Lactobacillus sp.***

539 DMKU <-P. Srisomwong L37
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 15 C

540 DMKU <-P. Srisomwong L39
SOURCE : Fermented pork (*Nham*)
Heterofermentative
Grow at 15 C ,45 C

866 S. Tanasupawat F20
=NRIC 0136
SOURCE : Pickled onion (*Hom-dong*)

882 S. Tanasupawat FP37-1
SOURCE : Fermented tea leaves (*Miang*)
%G+C 47

891 S. Tanasupawat A28
=NRIC 0127
SOURCE : Fermented pork (*Nham*)

913 S. Tanasupawat FP51-1
=NRIC 0133
SOURCE : (*Pak-koom dong*)

***Leuconostoc dextranicum*** (Beijerinck) Hucker & Pederson

056 DMKU <-ATCC 19255

377 M.Kozaki <-TUA 204

454 M.Kozaki <-TUA 204L

474 DMKU <-B.Saeng-on 8m8/25B
SOURCE : Sugar factory

***Leuconostoc mesenteroides*** (Tsenkovskii) van Tieghem

053 DMKU <-ATCC 10830
Production of dextran

120 UPCC 44

473 DMKU <-B. Saeng-on 8m8/25A
SOURCE : Sugar factory
Production of dextran

478 MSDS <-ATCC 8042
Assay of amino acids

942 S. Tanasupawat
=NRIC 1541 ;ATCC 8293
Type strain

***Pediococcus acidilactici*** Lindner

051 DMKU <-ATCC 8042
Assay of amino acids

397 NISL 7113

424 DMKU <-S. Tanasupawat N53 [06 ;07 ;08]
SOURCE : Fermented pork (*Nham*)

425 DMKU <-S. Tanasupawat N54 [06 ;07 ;08]
SOURCE : Fermented pork (*Nham*)

783 ATCC 33314 [03]
Type strain

***Pediococcus halophilus*** Mees

332 DMKU B-119 <-S. Suknaisilp no.78
SOURCE : Soy sauce

333 DMKU B-120 <-S. Suknaisilp no.82
SOURCE : Soy sauce
Lactic acid produced 88.24 % [09]

334 DMKU B-121 <-S. Suknaisilp no.83
SOURCE : Soy sauce
Lactic acid produced 97.96 % [09]

429 DMKU <-S. Tanasupawat PH01
SOURCE : Fermented fish (*Pla-ra*)
Lactic acid produced 97.96 % [09]

430 DMKU <-S. Tanasupawat PH25 [10]
SOURCE : Fermented fish (*Pla-ra*)

431 DMKU <-S. Tanasupawat PH27 [10]
SOURCE : Fermented fish (*Pla-jom*)

432 DMKU <-S. Tanasupawat PH45 [10]
SOURCE : Fermented fish extract (*Nam-pla*)
Lactic acid produced 93.65 %

433 DMKU <-S. Tanasupawat PH47 [10]
SOURCE : Fermented sea clam (*Hoi-dong*)

434 DMKU <-S. Tanasupawat PH59 [10]
SOURCE : Fermented shrimp (*Kung-jom*)

435 DMKU <-S. Tanasupawat PH65 [10]
SOURCE : Fermented fish (*Pla-jom*)

436 DMKU <-S. Tanasupawat PH88 [10]
=JCM 2016
SOURCE : Fermented saltwater fish (*Bu-du*)

437 DMKU <-S. Tanasupawat PH120 [10]
SOURCE : Fermented fish entrails (*Tai-pla*)

438 DMKU <-S. Tanasupawat PH130 [10]
SOURCE : Fermented fish entrails (*Tai-pla*)

439 DMKU <-S. Tanasupawat PH155 [10]
SOURCE : Fermented fish (*Pla-jom*)

***Pediococcus pentosaceus*** Mees

374 TUA P-19

413 DMKU <-S. Tanasupawat N01 [07 ;10]
SOURCE : Fermented pork (*Nham*)
Lactic acid produced 91.14 %

414 DMKU <-S. Tanasupawat N31 [07 ;10]
=JCM 2023
SOURCE : Fermented fish cake (*Pla-som*)
Lactic acid produced 84.72 %
%G+C 31

415 DMKU <-S. Tanasupawat N37 [07 ;10]
=JCM 2024
SOURCE : Pickled bastard mustard (*Pak-sian dong*)
Lactic acid produced 96.98 %
%G+C 37.5

416 DMKU <-S. Tanasupawat N38 [07 ;10]
SOURCE : Fermented pork (*Nham*)
Grow at 42 C

417 DMKU <-S. Tanasupawat N78 [07 ;10]
SOURCE : Fermented pork (*Nham*)
Lactic acid produced 82.01 %

418 DMKU <-S.Tanasupawat N91 [10]
SOURCE : Pickled black mustard (*Pak-gard dong*)

419 DMKU <-S. Tanasupawat N133 [07 ;10]
=JCM 2027
SOURCE : Fermented pork sausage (*Sai-krok prieo*)

420 DMKU <-S. Tanasupawat N256 [07 ;10]
SOURCE : Fermented pork (*Nham*)
Lactic acid produced 90.17 %

421 DMKU <-S. Tanasupawat N271 [07 ;10]
SOURCE : Fermented fish cake (*Pla-som*)
Lactic acid produced 96.65 %

422 DMKU <-S. Tanasupawat N278 [07 ;10]
SOURCE : Fermented pork sausage (*Sai-krok prieo*)
Grow at 42 C

423 DMKU <-S. Tanasupawat N295 [07 ;10]
SOURCE : Fermented fish cake (*Som-fak*)
Grow at 42 C

954 DMKU <-S. Tanasupawat
SOURCE : Fermented rice (*Khao-mak*)

955 DMKU <-S. Tanasupawat
SOURCE : Fermented rice (*Khao-mak*)

***Pediococcus sp.***

129 M.Sundhagul
SOURCE : Japanese fermented food

394 DMKU <-S. Tanasupawat <-IAM1684

529 DMKU <-P. Srisomwong P1 [05]
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 45 C

530 DMKU <-P. Srisomwong P8 [05]
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 45 C

531 DMKU <-P. Srisomwong P2 [05]
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 45 C

532 DMKU <-P. Srisomwong P3 [05]
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 45 C

533 DMKU <-P. Srisomwong P5 [05 ;06]
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 45 C

534 DMKU <-P. Srisomwong P10 [05 ;06]
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 45 C

535 DMKU <-P. Srisomwong P11 [05]
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 45 C

536 DMKU <-P. Srisomwong P17 [05 ;06]
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 45 C

537 DMKU <-P. Srisomwong P18 [05 ;06]
SOURCE : Fermented pork (*Nham*)

538 DMKU <-P. Srisomwong P20 [05 ;06]
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 45 C

545 DMKU <-P. Srisomwong P27 [05]
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 45 C

546 DMKU <-P. Srisomwong P31 [05]
SOURCE : Fermented pork (*Nham*)
Homofermentative
Grow at 45 C

***Pediococcus urinae-equi*** Mees

426 DMKU <-S. Tanasupawat N86 [07]
=JCM 2021
SOURCE : Pickled black mustard (*Pak-gard dong*)
Lactic acid produced 84.90 %

427 DMKU <-S. Tanasupawat U01 [07]
SOURCE : Horse urine
Lactic acid produced 88.33 %

***Streptococcus cremoris*** Orla-Jensen

058 W. Daengsubha
SOURCE : Yoghurt starter

456 M.Kozaki <-TUA 439L

***Streptococcus faecalis*** Andrewes & Horder

379 M.Kozaki <-TUA 369 =ATCC 19433 [*Enterococcus faecalis*]
=ATCC 19433

459 M.Kozaki <-TUA 194L

***Streptococcus lactis*** (Lister) Lohnis

457 M.Kozaki <-TUA 154L

***Streptococcus sp.***

928 S. Tanasupawat
SOURCE : Fermented fish (*Pla-jom*)

929 S. Tanasupawat
SOURCE : Fermented fish (*Pla-som*)

930 S. Tanasupawat
SOURCE : Fermented pork sausage (*Sai-krok prieo*)

931 S. Tanasupawat
SOURCE : Pickled black mustard (*Pak-gard dong*)

932 S. Tanasupawat
SOURCE : Fermented tea leaves (*Miang*)

933 S. Tanasupawat
SOURCE : Fermented beef sausage [Mum]

***Streptococcus thermophilus*** Orla-Jensen

458 M.Kozaki <-TUA 196L

| | |
|---|---|
| 047 | Lactobacillus casei subsp. rhamnosus |
| 048 | Lactobacillus buchneri |
| 050 | Lactobacillus plantarum |
| 051 | Pediococcus acidilactici |
| 053 | Leuconostoc mesenteroides |
| 055 | Lactobacillus fermentum |
| 056 | Leuconostoc dextranicum |
| 058 | Streptococcus cremoris |
| 108 | Lactobacillus delbrueckii |
| 120 | Leuconostoc mesenteroides |
| 129 | Pediococcus sp. |
| 326 | Lactobacillus delbrueckii |
| 332 | Pediococcus halophilus |
| 333 | Pediococcus halophilus |
| 334 | Pediococcus halophilus |
| 372 | Lactobacillus casei subsp. rhamnosus |
| 373 | Lactobacillus plantarum |
| 374 | Pediococcus pentosaceus |
| 377 | Leuconostoc dextranicum |
| 379 | Streptococcus faecalis |
| 388 | Lactobacillus acidophilus |
| 389 | Lactobacillus casei |
| 390 | Lactobacillus casei |
| 391 | Lactobacillus fermentum |
| 394 | Pediococcus sp. |
| 397 | Pediococcus acidilactici |
| 398 | Lactobacillus cellobiosus |
| 413 | Pediococcus pentosaceus |
| 414 | Pediococcus pentosaceus |
| 415 | Pediococcus pentosaceus |
| 416 | Pediococcus pentosaceus |
| 417 | Pediococcus pentosaceus |
| 418 | Pediococcus pentosaceus |
| 419 | Pediococcus pentosaceus |
| 420 | Pediococcus pentosaceus |
| 421 | Pediococcus pentosaceus |
| 422 | Pediococcus pentosaceus |
| 423 | Pediococcus pentosaceus |

538 Pediococcus sp.
539 Lactobacillus sp.
540 Lactobacillus sp.
541 Lactobacillus plantarum
542 Lactobacillus plantarum
543 Lactobacillus plantarum
544 Lactobacillus plantarum
545 Pediococcus sp.
546 Pediococcus sp.
683 Lactobacillus fermentum
783 Pediococcus acidilactici
785 Lactobacillus delbrueckii subsp. lactis
844 Lactobacillus plantarum
845 Lactobacillus pentosus
846 Lactobacillus plantarum
847 Lactobacillus pentosus
848 Lactobacillus pentosus
849 Lactobacillus pentosus
850 Lactobacillus plantarum
851 Lactobacillus pentosus
852 Lactobacillus pentosus
853 Lactobacillus pentosus
854 Lactobacillus plantarum
855 Lactobacillus brevis
856 Lactobacillus pentosus
857 Lactobacillus pentosus
858 Lactobacillus plantarum
859 Lactobacillus pentosus
860 Lactobacillus brevis
861 Lactobacillus plantarum
862 Lactobacillus plantarum
863 Lactobacillus plantarum
864 Lactobacillus plantarum
865 Lactobacillus pentosus
866 Lactobacillus sp.
867 Lactobacillus pentosus
868 Lactobacillus brevis
869 Lactobacillus pentosus

| | |
|---|---|
| 870 | Lactobacillus pentosus |
| 871 | Lactobacillus pentosus |
| 872 | Lactobacillus pentosus |
| 873 | Lactobacillus pentosus |
| 874 | Lactobacillus pentosus |
| 878 | Lactobacillus pentosus |
| 879 | Lactobacillus fermentum |
| 880 | Lactobacillus pentosus |
| 881 | Lactobacillus confusus |
| 882 | Lactobacillus sp. |
| 890 | Lactobacillus sake |
| 891 | Lactobacillus sp. |
| 911 | Lactobacillus sake |
| 912 | Lactobacillus sake |
| 913 | Lactobacillus sp. |
| 914 | Lactobacillus fermentum |
| 915 | Lactobacillus fermentum |
| 919 | Lactobacillus mali |
| 920 | Lactobacillus pentosus |
| 926 | Lactobacillus plantarum |
| 928 | Streptococcus sp. |
| 929 | Streptococcus sp. |
| 930 | Streptococcus sp. |
| 931 | Streptococcus sp. |
| 932 | Streptococcus sp. |
| 933 | Streptococcus sp. |
| 934 | Lactobacillus confusus |
| 937 | Lactobacillus fermentum |
| 938 | Lactobacillus curvatus |
| 939 | Lactobacillus halotolerans |
| 940 | Lactobacillus pentosus |
| 941 | Lactobacillus pentosus |
| 942 | Leuconostoc mesenteroides |
| 945 | Lactobacillus fermentum |
| 946 | Lactobacillus fermentum |
| 947 | Lactobacillus fermentum |
| 948 | Lactobacillus fermentum |
| 949 | Lactobacillus fermentum |

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