3. Investigation

# The Traditional Fermented Foods and their Microflora in Southeast Asia

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## INTRODUCTION

When we describe food culture of Southeast Asia, it is said that we can categorize it in three zones: *miso-shoyu* cultural zone (*miso*/soy paste-a fermented paste of soybeans, salt and often rice or barley, used esp. to flavor soups and sauces. *shoyu-soy* sauce, a salty, fermented sauce made from soybeans, used esp. as a flavoring in East Asian cuisine), curry cultural zone and coconut cultural zone *(4)*. In regard to climate, they belong almost to a same monsoonal area, but those zones have respective features as continental or oceanic cultures. Those nations said to be included in *miso-shoyu* cultural zone are Japan, Korean Peninsula, China, Taiwan, Laos and Vietnam; in curry cultural zone are Nepal, India, Bangladesh, Burma, Thailand, Cambodia, Malaysia, Singapore and Western Indonesia; and in coconut cultural zone are Borneo, Eastern Indonesia and Philippines. These nations have own traditional fermented foods in ethnically and food culturally. In some area, they are mixed, and others exist as peculiar in their country of origin.

When we categorize these traditional fermented foods in usage, they are alcoholic beverage, side-dish foods, seasoning and pickled foods which are essential food groups regarded extremely important in diet of nations in Southeast Asia. These ingredients range in variety as those from plant, from fish and from both plant and fish. Most of those traditional fermented foods in these three food cultural zones are worth paying attention in common because they have a great role in the product and quality of food group by microflora containing a number of bacteria, yeast and filamentaous fungi.

Special natural environment where nations of Southeast Asia exit has beneficial microflora with peculiar strong fermentative activity, being believed that it is serving for production of traditional fermented foods.

The outline for these fermented foods is described in "*Microbiology of Fermented Foods*" by Brian J.B. Wood *(1)*, for traditional fermented foods especially in Southeast Asia, "*The role of Microorganisms in food fermentation with special reference to Malaysian fermented foods*" by Mohamd Ismail *(2)*, and *Symposium Report* by the same author *(3)*. Also, for ragi which acts an important role as inoculum in fermented foods of

Southeast Asia, "*Ragi and it's Utilization for the Manufacture of Fermented Foods in Indonesia*" by Jenny K.D. Saono (1982) *(4)* and others. This report introduces traditional fermented foods in Southeast Asia, categorizing in alcoholic beverage, side dish foods and seasonings with mainly its way of production and microflora.

## 1. Ragi as inoculum

*Ragi* is made mainly of glutinous rice of high-starch and *cassava*, tropical plants belonging to the genus *Manihot*, of the spurge family, and is used for production of fermented foods. This is a kind of base for fermentation, that is a starter. We crush glutinous rice and spice into small pieces, mix and knead with water, and make dough. Then we make the dough into a ball, then into a disk, complete it by leaving statically in high-temperature and high-moist place.

In detail, we mix powdered rice, garlic and ginger with spice, add boiled and cooled water to it, and make dough. We form a disk of 25mm diameter with 5mm thickness, sprinkle ready-made ragi powder, cover with rice straws. It is cultivated for 2 days at room temperature and have bacteria grown on the surface of the dough. We complete it with drying in the sun.

Usually ragi shows white color but when used with red pepper as spice, it shows orange or light brown. Applied spice to ragi is said to prevent growth of contaminant and help grow beneficial strains in ragi. Therefore there are a great number of additive spices. As an example, incorporation ratio of plant materials used for the manufacture of ragi is as shown in Table 1.

Researches screening and identifying microflora forming ragi are as follows: at first in 1894, a Nedtherlander Eijkman *(5)* isolated mold containing dexterose-converting activity and referred to it as *Amylomyces rouxii*. Then in 1900, Wehmer *(6)* isolated *Mucor javanicus* and *Mucor dubius*, alcohol-generating bacteria from ragi. After 30 years of these pioneering researches on microflora of ragi, Ochse *(7)* isolated *Mucor dubius*, *Mucor javinicus*, *Chalamydomucor oryzae*, *Rhizopus oryzae*, *Saccharomyces vodermanii*, *Willa indica* (*Torula indica*) and *Candida javanica* from ragi. The same research was done also by Heine *(8)* after 50 years. Later, Hesseltine *(9)* revealed that in these microbes, *Candida javanica* and *Hansenula anomula* are the same bacterium, also, so are *Saccharomyces vodermanii* and *Saccharomyces cerevisiae*.

After 1970's, more species of strains forming ragi were screened by researchers of Indonesia, Japan and America. Also, fermentative studies were undertaken.

Dwidjoseputro *et al. (10,11)* tried isolatating and identifying microflora which grows on ragi. They isolated and identified *Candida parapsilosis*, *C. melinii*, *C. lactosa*, *C. solani*, *Hansenula subpelliculosa*, *Rhizopus oligosporus*, *Aspergillus flavus*, *A. oryzae* and *Hansenula malanga*. Later, Ko Swan Djien *(12,13)* isolated *Endomycopsis chodati*, *E. fibuligera*, *Mucor rouxii*, *Rhizopus stolonifer* and *Aspergillus niger*. In 1972, Saono *et al. (14)* examined 14 kinds of ragi collected from Western Java area and their fungiflora and

isolated 6 strains of yeast and 4 kinds of mold. Soedarsono *(15)* isolated some kinds of fungi belonging to *Aspergillus*, *Chlamdomucor* and *Saccharomyces*. Kato *et al. (16)* isolated yeast with strong glucoamylase activity from ragi and identified as *Endomycopsis fibuligera*. At the same time he succeeded in crystallization of glucoamylase this fungus produces.

Table 1 Incorporation ratio of plant materials used for the manufacture of "RAGI"

| Plant materials | Number of homescale plants* | Incorporation ratio**(%) |
|---|---|---|
| Rice | 25 | (100) |
| Garlic | 24 | 1-19 |
| "Laos"Alpinia galangal | 21 | 3-50 |
| white pepper | 21 | trace- 6 |
| Red cgli pepper | 12 | trace- 4 |
| Cinnamon | 5 | trace- 4 |
| Black pepper | 3 | trace- 3 |
| "Adas" Foeniculum valgare | 3 | 3 |
| Sugar cane | 2 | 1-13 |
| Lemon | 1 | 4 |
| Coconut | 1 | 50 |

*The number of home-scale plants investigated were 25.
**expressed in percentage for rice.

As for examples executed isolation and identification including bacteria, Endang *et al. (17)* isolated 13 strains of mold, 9 strains of yeast and 17 strains of acid generating bacteria from ragi produced in Central Java. Among 13 kinds of mold, 11 strains were identified as *Zygorhynchus molleri* and 2 strains as *Rhizopus cohnii*. Among 9 strains of yeast, 8 strains were identified as *Candida* sp., 1 strain as *Torula* sp. and acid producing bacteria were all identified as *Pediococcus pentosaceus*. On bacteria growing on ragi, Toyoda *et al. (18)* revealed that they admitted cocci which main fungiflora of *Pediococcus pentosaceus* and bacilli in new ragi but bacilli disappeared as ragi gets old as time passes.

According to reports by Saono *et al. (19)* ragi contains molds, yeast and bacteria with amylolytic power; and yeast and bacteria (lactic acid bacteria) with non-amylolytic power. Those with amylolytic power in mold are *Amylomyces*, *Mucor*, and *Rhizopus*, in yeast are *Endomycopsis* (*Saccharomyces*) and *Candida*, and in bacteria contained a kind belonging to *Bacillus*. Table 2 and 3 show that the number of amylolytic yeast is the greatest. Moreover, Table 4 is a summary of main microbes screened, isolated and identified in ragi.

Table 2 Characterization of microflora in "RAGI"

| | Microflora | Characterization |
|---|---|---|
| Amylolytic fungus | *Amylomyces* sp. | Saccharification |
| | *Mucor* sp. | Liquefaction |
| | *Rhizopus* sp. | Saccharification<br>Alcohol production |
| Amylolytic yeast | *Endomycopsis* sp. | Saccharification |
| | *Candida* sp. | Poor odor production |
| Non-Amylolytic yeast | *Saccharomyces* sp. | Alcohol production |
| | *Hansanula* sp. | Good aroma production |
| | *Endomycopsis* sp. | |
| | *Candida* sp. | Specific odor production |
| Lactic acid bacteria | *Pediococcus* sp. | Lactic acid production |
| Amylolytic bacteria | *Bacillus* sp. | Saccharification |

Table 3 Number of microorganisms in "RAGI"

| Microorganisms | Order of Number (per g RAGI) | Number of RAGI samples* |
|---|---|---|
| Amylolytic fungus | $10^4$-$10^5$ | 16 |
| | $10^6$-$10^7$ | 8 |
| Amylolytic yeast | $10^2$-$10^3$ | 2 |
| | $10^4$-$10^5$ | 4 |
| | $10^6$-$10^3$ | 18 |
| Amylolytic bacteria | less than $10^4$ | 22 |
| | $10^4$-$10^5$ | 2 |
| Lactic acid bacteria | less than $10^3$ | 22 |
| | $10^3$-$10^4$ | 2 |

*The number of RAGI sample used were 24.

Table 4 Genuses and species of microorganisms in RAGI

| | | | |
|---|---|---|---|
| *Amylomyces* | *rouxii* | *Candida* | *lactosa* |
| | | | *melinii* |
| | | | *parapsilosis* |
| *Mucor* | *javanicus* | | *solani* |
| | *dubius* | | |
| | *rouxii* | *Endomycopsis* | *chodai* |
| | | | *fibuligera* |
| *Rhizopus* | *oryzae* | | |
| | *arrhizus* | *Hansenula* | *anomula* |
| | *oligosporus* | | *malanga* |
| | *stolonifer* | | *subpelliculosa* |
| | *cohnii* | | |
| | | *Saccharomyces* | *cerevisiae* |
| *Zygorynchus* | *molleri* | | |
| | | *Willa* | *indica* |
| *Aspergillus* | *flavus* | *Pediococcus* | *pentosaceus* |
| | *niger* | | |
| | *oryzae* | *Bacillus* | sp. |
| *Chlamydomucor* | *oryzae* | | |

## 2. Alcohol Drink

In Southeast Asia there are many kinds of original local brew (alcohol drink). Arak beras, Binuburan and Pachwai are produced by fermenting rice mixed with ragi. Arak beras is greatly loved to drink among the native race of Sarawak. Binuburan is a nickname in Philippines, Pachwai is a popular name in India. Those are extremely similar to Japanese *doburoku* (strong local brew) which ragi as inoculum is mixed with steamed rice, added water and fermented. The fermentation period prolongs several weeks. The products in the very last stage of fermentation present almost extract form, being drunk as finished products. Southeast Asia belonging in monsoonal area is active in rice plantation historically. The production of the local brew of this kind is done in every region. Generally speaking, it is rice wine. In Eastern Malaysia (Borneo), Eastern Indonesia and Philippines belonging to coconut cultural zone drink natural fermented alcohol drink by collecting coconut juice. This is so called coconuts wine. The main microflora of these alcohol drinks are said to be yeast and several kinds of bacteria. The most popularly detected are yeasts belonging to *Saccharomyces*, *Endomycopsis* and *Hanensula genus (3)* (Table 5).

Table 5 Fermented Alcohol Drink

| Local name | Materials | Uses | Microorganisms involved |
|---|---|---|---|
| Arak beras (Malaysia)<br>Binuburan (Philippine)<br>Pachwai, Torani (India) | Steamed rice<br>Ragi | Beverage | *Saccharomyces* sp.<br>*Endomycopsis* sp.<br>*Hansenula* sp.<br>etc. |

## 3. Side Dishes

1) Tempeh

*Tempeh* is fermented soybean foods by having the whole soybean being covered with *Rizopus oligosporus*. It is popular among many people especially in Western Indonesia (Malay Peninsula). Tempeh has great demand as supplemental foods substituting for meat with animal protein because it contains abundant of vegetable protein.

The method to process tempeh by traditional way is as follows: first, soybeans are cleaned and soaked in water for around half a day. Then, water on the soybeans as the raw material is drained off. The soybeans are stewed in a pot until well softened. After being stewed, the soybeans are cooled and its water are drained off. Fungi are applied to these soybeans as inoculum. Inoculum applied soybeans are covered with banana leaves or other trees useful to cover.

After these processes, they are fermented at a warm place for 24 to 48 hours. In these days, there is a tendency to use plastic bags to tree leaves. In either way, its aim is to maintain the product uncomfortable. After the fermentation, these soybeans present cake-like figure with full Fungi's white mycelia produced all over. There are many recipes to it: they are eaten sliced as a finished food, fried in deep cooking oil or mixed in soup.

Main microbes in relation to this tempeh fermentation are *Rhizopus oligosporus*. There is a case other

molds belonging to the genus *Rhizopus* such as *Rhizopus oryze*, *Rhizopus stolonifer* and *Rhizopus arbizus (20)*. These microbes produce enzyme as protease, amylase and pectinase. Most of soybean protein is dissolved to amino acid, so is fat to free fat acid *(21)*. According to the research by Leim, I.T.H. *(22)*, there is vitamin $B_{12}$ production and *Klebsiella Pneumoniae* involves in it.

2) Tapai or Tape

*Tapai* and *tape* are sweet-and-sour paste produced by rice and cassava. Cassava is starch extracted from fruits belonging to the genus *Manihot*, of the spurge family. To prepare for traditional tapai or tape, glue-stated prepared rice and cassava are mixed, stewed or steamed. In this mixture, mixed ragi as inoculum in 10 to 1 proportion and inoculated. For stewed rice or steamed rice, ragi is mixed, but for cassava only, ragi is sprinkled on the surface and inoculated. After inoculation in both cases, they are wrapped with banana leaves or plastic bags.

Inoculated prepared products are left statically in a warm place, fermented for 2 to 3 days and served to eat.

Through the fermentation, starch of rice or cassava is decomposed into glucose and acid by action of fungi or a certain kind of lactic acid bacteria *(3)*. Yeast takes a role to convert to alcohol under the existence of glucose and acid. In the last stage of this product, it presents soft and sweet-and-sour taste with its pH about 4 *(4)*.

Ko reports in his researches *(12,13)* that in this product yeasts such as *Chlamydomucor oryzae*, *Endomycopsis fibuliger* and *Hansenula anomala* and various kinds of lactic acid bacteria involve and they are said to proceed the fermentation.

Tapai is the name in Malaysia and so is tape in Indonesia.

3) Idli and Dosai

*Idli* and *dosai* are the most popular fermented food originated in India seen in Southeast Asian region. Idli is steamed crops and dosai is pancakes. This product is taken as a part of usual breakfast or light meal. Idli is mixed with black chick pea and powdered rice in 1 to 2 proportion and prepared after soaking for about 3 to 4 hours. This mixture and the product made butter-like are fermented for 12 to 18 hours in room temperature. To promote the product's fermentation, a certain volume of salt or baking powder is added to the above mixture and the product made butter-like. Fermented butter-like product are placed in molds and steamed for about 20 minutes.

Idli can be eaten as breakfast or with coconut chanet (sweet-and-sour seasoning originating in India made from herbal plants or acetic acid) or other seasoning and spice.

The method to prepare dosai is basically same to that of idli, but the ingredients are mixed in 6 to 1 proportion and mixed with fenugreek (plant of Leguminosae family) and other mixture. Just before eating,

they are diluted with water, melted, poured into a flying pan and baked as pancake. Desikachar *(23)* reports that the microflora produced at the stage of fermentation of butter-like mixture is, in most of the cases, lactic acid bacteria of the genus *Leuconostoc*. Most of other microbes related from fermentation environment or fenugreek themselves. These microbes take an important role for acid produced partly, production of gas and preservation of butter (Table 6).

Table 6 Fermented Side Dishes

| Local name | Materials | Uses | Microorganisms involved |
|---|---|---|---|
| Tempeh (Malaysia)<br>(Indonesia) | Soy bean<br>Fungi | Snacks<br>Soups | *Rhizopus*<br><br><br><br>*Klebsilla* |
| Tapai (Malaysia)<br>Tape (Indonesia) | Steamed rice<br>Cassava<br>Corn<br>Banana<br>Ragi | Desserts<br>Snacks | *Chalaymydomucor*<br>*Endomycopsis*<br>*Hansenula* |
| Idli (India)<br>Dosai (India) | Black gram<br>Ground rice<br>Baking powder<br>Salt | Breakfast<br>Snacks | *Leuconostoc* sp.<br><br><br>etc. |

## 4. Seasoning Foods

1) Tempoyak

*Tempoyak* is prepared with a slight volume of salt to flesh and rind of durian. The product is yellowish cream with unique durian's aroma of sulfur. The demand of this product is very few but it is a necessary seasoning food for special foods. It is believed that tempoyak is extremely effective for appetite stimulant and appetizer for a certain age group of people. The flavor and taste of this product are said to be unique.

The method to prepare this product is to have it fermented for several weeks with 3 to 7% salt to flesh and rind part of durian. This salty and a little sour fermented food is used only for special meals.

The microflora of this product has not yet been researched. However, there is a report that a certain kind of halotolerant bacterium has been detected *(3)*.

2) Budu, Kicap, Patis, Nam-pla, Nauc-nam, Ngapi or Nappi

These traditional fermented seasoning foods are the most demanded products in Southeast Asia and have been supplied in most of the countries. That is, they are unique seasoning foods in regions abundant of marine foods. A variety of names called show us their big demand such as in Malaysia they are called *budu*; in Indonesia, *kicap*; in Philippines, *patis*; in Thailand, *nam-pla*; in Burma, *ngapi*; and in vietnam, *nauc-nam*. Both ingredients and preparatory process of these products are almost same in any countries.

In Southeast Asian countries, these products are used as spice, sauce and ordinary dishes. Most of their

supply is in Malay Peninsula. It is said that they are mostly demanded in eastern beach side area especially such as Kelantan, Terengganu and Pahang. In other countries also, regions facing beach line are high in its production and demand.

This product is for fish to the genus *Stolophorus*, added with around 20% salt, and prepared in clay pots or concrete tanks. The mixture of small fish and salt is fermented for about 6 months in room temperature. Dougan *et.al. (24)* report that there occur proteolysis with activity of proteolytic enzyme and others that bacteria under fermentation or fish have. Resolution of fat is resolved with fat resolving bacteria. Most of fat are converted to fat acid. The fishy smells of the sauce are believed by compounds such as volatile fat acid, several amino acid and others. At the very last fermentation stage, it presents clear brown liquid extract, potted after boiling or filtrated and potted with its aroma being increased with lime, sugar, tomato and others.

On the microflora in these products, Crisam *et.al. (25)* report that they detected the followings from nam-pla. Most of them are to the genus *Bacillus*; *Bacillus cereus*, *B. circulans*, *B. licheniformis*, *B. subtilis* and others. According to Amano and Sato's research *(26)* they are mainly to the genus *Micrococcus*, especially *Micrococcus nitrificans*. In research of other Japanese fish sauce-like products such as so called *Kusaya-jiru* soup, Ozaki *(27)* detected *Pseudomonus* sp., *Achromobacter* sp., *Flavobacterium* sp., *Corynebacterium* sp. and *Micrococcus* sp. and others. And for one of Japanese fish sauce *ishiri*, Kanzaki *et.al. (28)* report on its quality improvement but have not researched any for the microflora.

3) Belacan, Bagoog, Padec, Trassi, Prahoc or Kapi

This paste prepared from small fish and small shrimps is popularly used as spice broadly or addicts to dishes. This product made of small fish and small shrimps in the genus *Mysia* is called *belacan* in Malaysia, *bagoog* in the Philippines, *padec* in Laos, *trassi* in Indonesia and *prahoc* in Vietnam. Preparatory method to this product starts in mixing 1kg of salt to 22.5kg of water content small shrimps. First, small shrimps are soaked in salt water for 24 hours, then left outside the house until its water reduces to about 50%. Half dried small shrimps are placed in wooden bottles or appropriate containers. Or they are made into paste-like and left inside the room statically for about 7 days. The fermented paste is made into balls tightly and sold in solid at last. 100kg of small shrimps result in 45 to 50kg of finished goods.

As for the microflora, through the fermentation of this product detected many kinds of bacteria to the genus *Bacillus*, *Lactobacillus*, *Micrococcus*, *Pediococcus*, *Streptococcus* and others *(3)*.

4) Cincaluk

*Cincaluk* is made from small shrimps, rice and salt. The preparatory method is: small shrimps from the sea are well rinsed with freshwater and dried for 2 to 3 hours. Small shrimps are mixed with 20% saline solution and 6% rice in proportion and tapped in pots. They are left statically for about a month inside and completed. It is known *(3)* that protein resolution and lactic acid bacteria beneficial for fermentation give favorable influence to this product through the fermentative reservation period.

Cincaluk is popular among people in mainly western Malaysia (the Malay Peninsula). This product is one of the most famous seasoning foods not only in ordinary dishes but also in a variety of dishes. For direct use, cincaluk is mixed with sliced red pepper/onion or sprinkled.

For the microflora of the product, we have not found any research literature.

5) Pekasam

*Pekasam* is prepared form roasted rice, tamarind (the pod of a tropical plant, of the legume family), newly caught freshwater fish and salt. This product is used in various regions of Southeast Asia, originated mainly in Thailand, Vietnam and Burma. Differed from other seasoning foods, it has a specification that is produced and supplied in inland area.

The method to prepare this product: newly caught freshwater fish are pickled with 20% saline solution for 12 to 18 hours or applied 20% salt directory to freshwater fish. Salt contained freshwater fish, roasted rice and tamarind are mixed well in harmony and fermented for 3 to 5 weeks. Protein of the fish is resolved by enzyme fish obtain and microbial activity.

The microflora of pekasam is said to be almost lactic acid bacteria *(29)*. For its usage, served for ordinary dishes.

6) Kicap or Kecap

This product is called *kicap* in Malaysia and *kecap* in Indonesia. It is made from soybeans mainly into dark brown liquid with aroma. It is popular mainly for spice. Though we do not have specific literature, it is handed down by word of mouth that it is used first by Chinese a several thousand years ago, delivered to Japan then and improved many times by Japanese. Therefore, it is extremely similar to Japanese soy sauce, *shoyu*.

Preparation and production of this product is held under small-size domestic industry. Its production under traditional fermentation process is: homemade soybeans are cleaned, stewed until soft, drained and cooled for 12 to 18 hours. These soybeans are mixed with flour of 45～50% sodium bicarbonate. This mixture is spread out in a big bamboo plate with 5cm in depth. In this plate used many a time during fermentation process inhabit *Aspergillus*, bacteria group, yeasts and others. The mixture applied bamboo plates are piled up in 15 to 30cm on a wooden shelf. Soybean mixture adhered to bamboo plates start being crushed little by little and exposed to the open air for 2 days. At the very last stage of fermentation, it is changed to yellow or blue yellow. Soybeans containing microbe with spore are placed in a big clay pot and sealed with 15～20% saline water added. The fermentation period is 2 to 24 months in static condition according to the products quality contents. The dark brown liquid that is obtained at the completed stage of fermentation is drawn up in a siphon, filtrated with cheese cloth or collected by an appropriate squeezer. Collected liquid (sauce) is tapped directly or added sugar or benzonic acid just before tapping. Or, up to 80% in range, is added to this liquid (sauce) and tapped after boiling.

For preparation and fermentation of this light sauce required 1.5 to 6 months and for strong sauce, 6 to 24 months. In extract process, collected supernatant fluid brine of unrefined sake (about 10 to 14%) in repetition for 4 to 6 times.

To prepare soybeans sauce, there are aerobic manufacturing method and anaerobic manufacturing method. In aerobic manufacturing method, mixture of soybeans and flour is inoculated with *Aspergillus oryzae* or *Aspergillus soyae*. The genus *Aspergillus* inhabit within the culture and decompose protein into amino acid or convert fat into fat acid. They have activity of enzyme converting into oligosaccharide and polysaccharide in unrefined *sake (30)*. Next fermentation stage starts when unrefined sake reaches to salt constituency that enables fungi activity. The fermentation in this anaerobic environment is lactic acid bacteria converting into alcoholic fermentation by yeast of next stage *(30)*. Lim *(31)* admits the existence of the genus *Monilia*, *Penicillium* and *Rizophus* in the unrefined sake. In general, it is known that *Lactobacillus delbrueckii* and *Pediococcus soyae* involve greatly to lactic acid fermentation. On the other hand, halotolerant bacteria *Pediococcus soyae* inhabiting in 15 to 18% salt constituenty are extremely beneficial lactic acid bacteria to inhibit anaerobic putrefactive bacteria producing in unrefined sake *(32)*. Also *Saccharomyces soyae* and *Saccharomyces rouxii* are detected in unrefined sake *(33)*.

The reason soybean sauce has taste of typical meat is because there exist fat acid or aroma acid *(30)*. Main taste found in soybean sauce is the existence of glutamate with great involvement of *Saccharomyces rouxii* and the genus *Torulopsis* in producing taste *(34)*.

7) Tauco

*Tauco* is a soybean paste, a fermented food in Indonesia only. This food is used half fermented. Its preparation is from soybeans, rice, barley and salt. It is used broadly in Southeast Asian countries. A similar product corresponds to miso or soy paste in Japan *(35)*. In Indonesia and Malaysia, it is called tauco. Its preparation method differs slightly in regions but in most cases, its ingredients are crushed soybeans and salt. For Japanese soy paste mixed salt and malted rice (made from steamed rice which is mixed with *Aspergillus oryzae* and cultivated) and prepared with steamed or stewed soybeans *(35)*.

This mixture requires about 2 to 3 months until supplied. Tauco of Indonesia and Malaysia is generally produced from light brown crushed soybeans and salt *(3)*. The preparation method is almost same to kicap except for no use of saline water.

It is believed that the microflora included in matrix through fermentation is almost the same kind to bacteria group detected in soybean sauce in general *(3)*. Also, it is considered that protease, carbohydrase, lipase, yeast and others are taking part in this maturation *(3)*.

This product is dried in the sun, packaged in semi-product and put on the market. In Malaysia, it hardly is dried in the sun. It is bottled in moist condition and put on the market (Table 7).

Table 7 Fermented Sauces

| Local name | | Materials | Uses | Microorganism involved | |
|---|---|---|---|---|---|
| *Tempoyak | (Malaysia) | Durian (fruit) | Flavouring | *Halophilic Microorganisms* | |
| | (Indonesia) | Durian (skin) | Dishes | | |
| | | Salt | Dips | | |
| *Budu, Kicap, Ikan | (Malaysia) | Stolophorus fishes | Flavouring Dishes | *Bacillus* | *cereus* |
| Ikan, Kecap | | Salt | Dips | | *circulans* |
| | (Indonesia) | | Condiments | | *licheniformis* |
| Patis | (Philippine) | | | | *megaterium* |
| Nam-pla | (Thailand) | | | | *subtilis* |
| Nauc-nam | (Vietnam) | | | *Micrococcus* | *nitrificans* |
| Ngagi, Nappi | (Burma) | | | *Pseudomonus* | sp. |
| | | | | *Achromobacter* | sp. |
| | | | | *Staphilococcus* | sp. |
| *Belacan | (Malaysia) | Mysia-fishes | Flavouring | *Bacillus* | sp. |
| Bagoong | (Philippine) | Shrimp | Dishes | *Lactobacillus* | sp. |
| Trassi | (Indonesia) | Salt | Dips | *Micrococcus* | sp. |
| Padec | (Laos) | | | *Pediococcus* | sp. |
| Prahoc | (Khamer) | | | *Staphilococcus* | sp. |
| Kapi | (Thailand) | | | | |
| *Cincaluk | (Malaysia) | Shrimp | Flavouring | *Some lactic acid bacteria* | |
| | | Rice | Dishes | | |
| | | Salt | Dips | | |
| *Pekasam | (Malaysia) | Roasted-rice | As dishes | *Some lactic acid bacteria* | |
| | | Tamarind | | | |
| | | River-fishes | | | |
| | | Lake-fishes | | | |
| | | Salt | | | |
| *Kicap | (Malaysia) | Soy bean | Flavouring | *Aspergillus* | *oryzae* |
| Kecap | (Indonesia) | Wheat flour | Dishes | | *soyae* |
| Shoyu | (Japan) | Salt | Dips | *Penicillium* | sp. |
| | | | Condiments | *Rhizopus* | sp. |
| | | | | *Saccharomyces* | *soyae* |
| | | | | | *rouxii* |
| | | | | *Torulopsis* | sp. |
| | | | | | *delbrueckii* |
| | | | | *Lactobacillus* | |
| | | | | *Pediococcus* | *soyae* |
| *Tauco | (Malaysia) | Soy bean | Flavouring | *Aspergillus* | *oryzae* |
| Tauco | (Indonesia) | Salt | Dishes | *Saccharomyces* | *rouxii* |
| Miso | (Japan) | | Dips | *Lactobacillus* | *delbuec* |
| | | | Soups | | |
| | | | | | etc. |

## SUMMARY

In traditional fermented food in Southeast Asia for purpose of preservation, many of them are with vegetable protein, carbohydrate, and fish protein as main raw material. To inhibit anaerobic putrefactive or other harmful bacteria, they have made good use of lactic acid bacteria, used high constituency salt to improve preservation or ragi as inoculum with wild beneficial bacteria for food in many purposes through their long historical life experiment. Among them admitted the existence of halotolerant lactic acid bacteria. Most of the traditional fermented foods are mainly alcoholic beverage, side dish foods and seasoning foods. What drew our attention especially was a seasoning food pekasam made from freshwater fish. The microbiological study on ragi has been started by Eijkman from 1894, having many kinds of microbes screened, isolated and identified. The role of the microflora on fermented foods is a very important issue on preservation, aroma, taste and nutrient. We can say that researches on the microflora of traditional fermented foods in Southeast Asia are expected in the future.

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## Brief Personal Record of the Author


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### Academic Background

Mar. 1960 - graduated from Faculty of Agriculture, University of Okayama
Mar. 1973 - graduated from the Graduate School of Agriculture, University of Okayama
Apr. 1987 - enrolled in the Graduate School of Natural Science and Technology, University of Okayama (doctor course)

### Professional Career

Feb. 1960 - joined in Ohi Securities Corporation
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Jun. 1982 - founded Ohhira Bio Activity Research & Development Center
Research on vegetable promoting cultivation exploiting microbiological enzyme and improvement of fruit sugar rate, also R&D of natural fermented foods
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### Awards

June 1979 - The Meritorious Services Prize from Sandakan Town Board, Malaysia
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