INTRODUCTION

Fermented foods are essential components of diets in many parts of the world especially in the Asia. It is a highly acceptable form of food preservation for millions of consumers due to its nutritious value and wholesome flavor.

The methods of processing traditional fermented foods were developed in households and improvements were done as the process is handled down from one generation to another. Mostly of these processes were developed on a trial and error basis, hence quality varied from one maker to the other.

In the Philippines, there are quite a number of traditional fermented foods such as rice wine (tapuy), sweetened rice (binubudan), fermented rice cake (puto), fermented cooked rice and shrimp (balao-balao), fermented cooked rice and fish (burong isda), sugarcane wine (basi), coconut wine (tuba), distilled coconut wine (lambanog), palm sap vinegar (suka), fermented fish paste (bagoong), fermented fish sauce (patia), fermented small shrimp (alamang), Visayan fermented fish (tinabal), green papaya pickles (achara), fermented mustard leaves (burong mustasa), green mango pickles (burong mangga), white soft cheese (kesong puti), and nata, a pellicle produced by Acetobacter xylinum on coconut medium (water or milk) fruit juices and other sugar-rich raw materials.

Technological advances that were made elucidated the role of microorganism on the physical and chemical changes that occurred in the processed raw materials. Microbial interactions during fermentation were affected by the existing environmental conditions and were found to influence the production and the wholesomeness of the products. Selected strains were employed in the process of improvement and standardization into the stable and high quality products and processes that are routinely used.

BACTERIAL FERMENTED FOODS

WHITE SOFT CHEESE (Kesong Puti)

Kesong puti is a traditional cheese made from fresh cow's or carabao's milk using rennet and lactic acid bacteria. It is prepared in rural households and normally consumed right after its preparation. The product is characterized as a mild acid-type soft cheese which is white in color. It is usually wrapped in fresh banana leaves hence its shelf-life is short at ambient temperature (28-30°C) and about one week at 5°C storage.

Kesong puti is a nutritious product due to its high protein content (23%), high amount of food energy (297 calories), calcium (323 mg%), phosphorous (166 mg%) and trace amount of vitamins and minerals. It has a pH of 5.50, total titrable acidity of 0.25% (expressed as % lactic acid), and 2.5% salt.

Preparation of Kesong Puti

The collected fresh milk is strained and volume determined. Rennet is added and the mixture is
stirred thoroughly and allowed to curdle for one half to one hour. When complete coagulation is attained, the curd is scooped into a perforated basin to drain the whey. The slightly drained curd is poured into the cheese molds where it is left to drain further by gravity. As a final step, the firm curd is cut and wrapped in banana leaves or plastic sheet.

Microorganisms in *Kesong Puti* Fermentation

After 24 hours of fermentation, different species of bacteria (belonging to *Lactobacillus*, *Streptococcus*, *Flavobacterium*, *Achromobacter*, *Pseudomonas*, *Serratia*, *Micrococcus* and *Aerobacter*) and yeasts (*Torula* spp.) were isolated. As fermentation progressed, the lactic acid bacteria such as *Streptococcus lactis*, *S. cremoris*, *S. diacetylactis* and *Lactobacillus casei* predominated and replaced the other microorganisms.

**Process Improvement**

The traditional method of manufacture of *kesong puti* was improved by pasteurizing the milk, addition of rennet and lactic acid starter culture consisting of *S. lactis*, *S. cremoris*, and *S. diacetylactis* either singly or in combination and addition of salt to the cheese milk for even distribution. Proper sanitation practices were also observed. A better keeping quality product with the characteristic flavor, texture and body was obtained with the new process.

**FERMENTED SHRIMP-COOKED RICE MIXTURE**

(*Balao-balao*)

*Balao-balao* is a traditional food consumed as a sauce or main dish after sauteing in vegetable oil with garlic and onion. The product is acidic with free-flowing consistency where the shell of the shrimp becomes red and soft and the rice starch is saccharified. A similar product in Thailand is known as *kung chao* or *hung sam* (*Vatana*, 1982).

Changes in acidity during fermentation at 28°C showed that from zero time to 10 days, pH decreased from 7.52 to 3.80, titrable acidity (as lactic acid) increased from 0.12 to 2.0% and volatile acid (as acetic acid) increased from 0.03 to 0.1%.

**Preparation of *Balao-balao***

The general method of preparation of *balao-balao* consisted of washing of the live shrimp (*Penaeus indicus* or *Macrobrachium* spp.), adding salt (20% based on the shrimp weight), allowing to stand for 2 hours before draining the mixture. Cooked cooled rice is then mixed with the shrimps at the ratio of 1 : 4.8 (weight of unsalted shrimp to rice). Salt (3%) is mixed thoroughly before the mixture is packed in wide mouth glass jars. The mixture is allowed to ferment for 7 to 10 days at 28°C.

**Microorganisms in *Balao-balao* Fermentation**

The Fermentation of *balao-balao* is carried out in a sequential manner whereby the first stage (up to 4 days) is dominated by cocci belonging to *Leuconostoc mesenteroides* which plays a major role in the acid production. On the fifth day the flora is dominated by *Pediococcus cerevisiae* and then shifted to *Lactobacillus plantarum* on the seventh day of fermentation. The changes of dominant flora during fermentation is overlapping which suggest that there was a change of conditions during the fermentation process that led to the death of one species and the enhancement of the other.

**FERMENTED FISH-COOKED RICE MIXTURE**

(*Burong Isda*)

*Burong isda* is a popular traditional food in the central part of Luzon particularly in Pampanga, Bulacan, Cavite and Nueva Ecija. Different variations of the product are made by using different species of fish such as *Ophicephalus striatus* (*burong dalag*), *Tilapia plumbeus* (*burong tilapia*), *Chanos chanos* (*burong bangus*), *Therapon plumbeus* (*burong ayungin*) with or without addition of red rice or *angkak* (produced by growing *Monascus purpureus* on cooked rice). The product is consumed as a sauce or as main dish after sauteing in vegetable oil with garlic and onion. Similar products are produced in other Southeast Asian countries like *phaak* or *manchao* in Cambodia, *pla-ra* in Thailand, *pekasam* and *cencalok* in Malaysia, *sikhae* in Korea and *narezushi* in Japan (*Johari*, 1978; *Lee*, et al., 1977).

**Preparation of *Burong Isda***

Fresh water fish is used in the preparation of *burong isda*. The fish is scaled, gills and fins are removed, then it is splitted into butterfly fillet. After thoroughly washing the fish, it is packed alternately with a mixture of cooked rice and 2.5%
salt at the ratio of 35 : 65 (salted cooked rice : fish). Fermentation is carried out for 7 days at 28°C to 30°C.

Microorganisms in Burong Isda Fermentation

Sequential changes of the bacterial flora occurred during burong isda fermentation wherein the dominant flora were Bacillus subtilis, B. cereus, Lactobacillus brevis, Streptococcus faecalis. Leuconostoc mesenteroides, Pediococcus cerevisiae, L. fermentum and L. plantarum.

During the fermentation process, starch hydrolysis occurred favoring the growth of the low acid tolerant lactic acid bacteria that later shifted to high acid tolerant lactic acid species. The activities of these microorganisms are influenced by the environmental conditions operating in the system.

Process Improvement

The process of preparation of burong isda was improved by addition of starter culture consisting of the dominant microorganisms isolated from the traditional method such as Pediococcus aceti lactici and Leuconostoc mesenteroides. The process was shortened to 4 days and the product is of better quality.

FISH PASTE (Bagoong) AND FISH SAUCE (Patis)

Bagoong and Patis is prepared in a similar manner, except that in the latter, fermentation is allowed to proceed until the flesh of the fish disintegrate into a liquid state. In the fermentation mixture, the solid state compose the bagoong while the liquid phase, the patis. The quality of both products vary depending on the method of manufacture and the kind of fish used.

Bagoong is characterized by its reddish brown color and is a salty paste with slightly cheese-like odor. Similar products are the trassi of Indonesia, belachan of Malaysia, kapi of Thailand, ngapi of Burma, and nam-ca of Vietnam (Johari, 1978, Lee, et al., 1977).

Patis is clear straw-yellow to amber in color depending on the type of fish used. The product is produced from the slow digestion or fermentation of salted fish and the subsequent separation of the solid from the liquid portion of the hydrolyzate. Patis is salty with cheese-like flavor and has a characteristic appetite-stimulating aroma. Similar products are the nuoc-mam in Cambodia and Vietnam, yu-hu in China, shottsuru in Japan, budu in Malaysia, jeot-kuk in Korea, nam-pla in Thailand and Laos, ketjap-ikan in Indonesia and nganpya-ye in Burma (Johari, 1978; Lee, et al., 1977).

Preparation of Bagoong and Patis

The common type of fish employed are dilis (Stolephorous spp.), tamban (Sardinella fimbriata), galonggong (Decapterus spp.). The fish is washed thoroughly and drained. Salt is mixed with the drained fish at varying proportion from 1 : 3 to 2 : 7 (salt : fish) depending on its size. The mixture is allowed to ferment in a warm (40°C) place for several months or longer until it develops the characteristic flavor and aroma of the product. Usually the preparation of patis takes a longer time than that of bagoong.

The chemical composition of six-month old patis showed that it has a pH of 5.85, 26.10% sodium chloride, 2.26% total nitrogen, 1.31% formol nitrogen, 0.31% ammonia nitrogen, 1.0% amino nitrogen and 0.84% lactic acid content. Patis contained 15 amino acids with no cystine and proline. The dominant amino acids are lysine (1083mg%), histidine (976mg%) and glutamic acid (960mg%).

Microorganisms in Bagoong and Patis Fermentation

The initial microorganisms found dominant in the salted fish consisted of Gram negative rods originating from the fish and the handlers. As the salt dissolved and the water from the fish extracted, these microorganisms were immediately killed due to the sensitivity of marine bacteria to hypertonic conditions.

The enzymes produced by Bacillus subtilis and B. coagulans in addition to the endogenous enzymes in the intestines of the fish cause protein hydrolysis. The bacterial enzymes were found to be responsible mainly for the deamination and decarboxylation of amino acids to form lower fatty acids and amides that produced the characteristic flavor of the product.

B. pumilus is the dominant species throughout the fermentation process. Other bacteria responsible for the early stage of fermentation were B. coagulans, B. megaterium and B. subtilis while B. licheniformis, Micrococcus colpogenes, M. roseus, M. varians and species of Staphylococcus on the
later stage of fermentation.

FERMENTED VEGETABLE AND FRUIT PRODUCTS

There are several traditional fermented vegetables and fruit products, namely burong mustasa (fermented mustard leaves), achara (green papaya pickles) and burong mangga (green mango pickles). They are usually consumed as appetizers or as an ingredient in main dish preparation.

Methods of Preparation

Burong mustasa is prepared from fresh mustard leaves mixed with rice broth (prepared by boiling one part rice with 5 parts water) with added 4.5% sodium chloride. Fermentation last for 3 to 4 days or until the desired acidity is reached.

Achara preparation consisted of an overnight fermentation of salted grated green papaya to have the desired firm and crispy texture. Other vegetables such as green pepper, carrot, ginger, and garlic are sliced in desired sizes and mixed together with the grated green papaya, packed in glass jars and cooled boiled pickling solution (4 parts vinegar and one part sugar) is added. The mixture is allowed to stand for 1-2 days before consumption.

Burong mangga is prepared from newly harvested green mango which is peeled, sliced into desired size, packed in jars and added with 3-4% sodium chloride solution. The mixture is allowed to ferment for 3-5 days at 30°C.

Microorganisms in Vegetable and Fruit Fermentation

At the initial stage of fermentation, species of Achromobacter, Aerobacter, Bacillus, Escherichia, Flavobacterium, Pseudomonas and comparatively low number of lactic acid bacteria were found. Under favorable conditions and due to the effect of salt these aerobic microorganisms were inhibited making way for the lactic acid bacteria belonging to Lactobacillus plantarum, L. lactis and Leuconostoc mesenteroides to dominate.

NATA

Nata is derived from a Latin word natare which means to float. It refers to the cellulosic pellicle formed by Acetobacter xylinum on the surface of sugar-enriched coconut water/milk, fruit juices and other materials. The substrate used to culture the organism, differentiate the kind of product such as nata de coco, produced from coconut water or coconut milk or highly diluted coconut milk and nata de pina, produced from pineapple medium.

Traditionally, cubed nata is sweetened and consumed as either dessert or ingredient of fruit salad. Today, nata find many uses in food preparations, medical applications and industrial products (Sanchez and Yoshida, 1998). Being a natural high fiber food, the popularity of nata in health and diet conscious consumers continues to grow. The tasteless and unique texture makes nata a versatile ingredient for main dishes as well as juices and other beverages, confectioneries, ice cream, yoghurt, salad, dessert, baked items, hamburger patties, sausages, tofu, kamaboko, and an (a Japanese red bean jam).

New application of this bacterial cellulose in the field of medicine and industry were due to its high crystallinity, purity, high water holding capacity, mechanical strength and restricted degradation on man and animal (White and Brown, 1989; Brown, 1992; Yamanaka, 1989). In medical field, bacterial cellulose found applications as temporary skin substitute for the treatment of wounds and second and third degree burns, as a surgical wipe, treatment pad, burn bandages or tissue/organ drape (Ring, et al., 1986; Fontana, et al., 1990 & 1991). Some industrial products utilizing the bacterial cellulose were diaphragms for electrostatic transducers such as loud speakers and headsets and for adding gloss, smoothness, ink receptivity in printing surfaces intended for commercial prints and other publications.

Preparation of Nata

Traditionally, the bacterial cellulose termed nata is prepared by inoculating A. xylinum into a liquid coconut medium formulated with 8% sugar and 1.2% acetic acid and fermented under still and aerobic conditions. Developments in the production of this product led to the production of cellulose under submerged agitated culture. With this new method, the length and width of the filaments can be controlled to suit whatever application the product is intended for.

PALM VINEGAR (Suka)
One of the oldest traditional fermented products is suka. Traditionally it is prepared from palm sap, the most common are nipa and coconut saps. The sap is allowed to ferment spontaneously wherein the alcoholic and acetous fermentation simultaneously proceed. Commercial process of vinegar production utilize the coconut water derived from the copra and desiccated coconut processing (Sanchez, et al., 1985). The process consisted of filtering the coconut water, formulating with sugar, pasteurizing and adding yeast starter (Saccharomyces cerevisiae) culture. The mixture is allowed to ferment for 2 weeks after which acetic acid fermentation commenced upon addition of Acetobacter aceti starter culture. The acetous fermentation is done for 2-3 weeks or until the product has 4-5% acetic acid content.

BACTERIAL AND YEASTS FERMENTED FOODS

Two indigenous alcoholic beverages are made in the Philippines which involved the spontaneous fermentation of sugar to ethanol by the yeasts and the conversion of small portion of sugars to lactic acid by bacteria. These alcoholic beverages are the sugarcane wine or basi and the coconut wine or tuba. A distilled high alcohol containing drink is produced from tuba which is termed lambanog. The microflora involved in fermentation is highly dependent on the raw materials, method of manufacture and prevailing environmental conditions which influence product quality.

SUGARCANE WINE (Basi)

Basi is one of the oldest traditional alcoholic beverages in the Philippines. History stated that it has been produced in the Ilocos Region since the 17th century. In 1960, basi was made the national drink for foreign dignitaries due to its peculiar taste and aroma which are not found in other local and even imported drinks. Two types of basi are available the sweet type for women and dry and bitter type for men.

Studies made to document the parameters involved in the basi fermentation revealed that there are variations among the methods of preparation, type of starter culture, additives used and quality of the product (Sanchez, 1981, 1982). The chemical composition of basi showed that reducing sugars ranged from 8.25 to 13.62%, pH from 3.18 to 3.60, acidity(0.1N NaOH/10ml) from 4.80 to 7.78 ml; ethanol from 10.95 to 14.18% and polyphenol content from 148 to 298mg%. The organic acids composition of basi consisted of lactate, acetate, pyruvate, malate, propionate, succinate and citrate at varying concentrations among the products of the different methods of preparation.

Preparation of Basi

The method of preparation of basi mainly differed on the source of microorganisms to effect the fermentation process. These are the bubod, prepared by mixing powdered rice with ginger, old bubod and water and samac (Macharanga grandifolia Linn.) leaves, bark and seeds.

The general procedure for preparing basi consisted of crushing the one-year old sugarcane stalks between two wooden or iron rollers provided with a long pole tied to a moving carabao, boiling of the sugarcane juice with added tangel (Ceriops tangelo Linn.) bark, green guava (Psidium guajava Linn.) leaves, and duhat (Sizgium cumminmu Linn.) bark. While the other method involves only the addition of leaves, bark and seeds of samac that serve as the inoculum and additives. The mixture is transferred to approximately 100-liter capacity earthen jars and allowed to cool down overnight before inoculating with binubudan (24-hour culture of steamed rice with old bubod) or inoculating with the dried leaves, seeds and bark of samac. The mixture is allowed to undergo alcoholic fermentation for one month after which the earthen cover is tightly cemented with wood ashes. The fermentation mixture is allowed to stand for 6 to 12 months before consumption. During this period, fermentation activity slows down until it ceases as basi undergoes aging.

Microorganisms in Basi Fermentation

Variations on the viable count were observed from the different samples of bubod and samac fruits, leaves and bark. Microbiological studies revealed that the dominant microflora of basi fermentation consisted of Saccharomyces cerevisiae, Pediococcus pentosaceus, and Lactobacillus casei. Other organisms that contributed to the flavor, aroma and stability of basi were S. bayanus, S.
rosei, S. capensis, Saccharomyces fibuligera, Sm. vini, and species of Candida and Torulopsis, among others.

**Process Improvement**

The improvement of the basi manufacture was accomplished by the adjustment of initial sugar concentration from 30-35° Brix to 25-28° Brix, optimization of the additives concentration and use of starter culture consisting of selected strains of S. cerevisiae, P. pentosaceus and L. casei. The product from the improved process have consistent quality with better bouquet, color, flavor, aroma and general acceptability. In addition, the yield was increased by 15%.

**COCONUT ALCOHOLIC BEVERAGES**

The coconut wine termed tuba is similar to toddy in Malaysia, Ceylon, Thailand and India, to nuoudua in Vietnam and tuack in Indonesia. Two types of tuba is made, one is sweet and low alcohol (2-4%) drink without added tangal bark so that it turns sour just few hours after sap collection. The other type is termed as bahalina in the Visayan region that involves the addition of tangal bark during the sap collection to inhibit the proliferation of acid-forming organisms and enable the yeasts to predominate producing a drink with higher ethanol (8-10%) content and a more stable product.

On the average, the chemical composition of tuba is 4.44% total solids, 0.71% sucrose, 1.95% invert sugar, 0.22% protein, 0.36% ash and 8.17% ethanol. Chromatographic analysis of the type of sugar present in coconut sap showed that it consisted of 0.24% glucose, 0.21% fructose, 13.4% sucrose, 0.07% inositol and 0.09% raffinose.

**Microorganisms in Tuba Fermentation**

The average viable cell count in the fermenting tuba showed that lower yeast and higher bacterial counts were obtained in treatment without added tangal bark in contrast with tuba with added bark. The dominant yeast isolated from tuba was Saccharomyces chevalieri while the other yeast species isolated were S. cerevisiae, S. capensis, S. rosei, S. vini, S. bailii, Candida vartiovaari, C. langeronii, C. diddensii and Torulopsis haemulonii. On the other hand, bacteria isolated were Acetobacter aceti, A. aceti subsp. xylinum, A. oxidans, Lactobacillus plantarum, L. leichmanii and L. acidophilus.

**Preparation of Tuba and Lambanog**

The unopened spadix of the coconut palm is slowly bent for several days before a very thin slice is made twice a day (morning and afternoon) to induce the flow of the sap. One-node bamboo tube measuring approximately 10-12 cm diameter and 40-45 cm length were used to collect the sap. The sap is allowed to spontaneously ferment for 24-48 hours before consumption or if it will be distilled into lambanog fermentation is carried out for an additional day. When tuba is to be stored for longer period, tangal bark is attended during the collection of the sap.

**FERMENTED RICE CAKE (Puto)**

The rice cake prepared through fermentation is called puto. There are two types of puto, the white in color and the one with added orange red pigment extracted from the seeds of Bixa orellana Linn. It is a spongy-type cake which is sweet and usually consumed with fresh grated coconut. Puto is an energy food which contains 214 calories per 100 grams portion. It also contains appreciable amount of vitamins and minerals.

**Preparation of Puto**

Puto is prepared from rice grains soaked overnight, ground with sufficient water, drained in muslin bag for 24 hours, inoculated with a day old mixture from the previous batch and allowed to undergo fermentation for approximately 14 hours before steaming. During the first stage fermentation (9 hours), the lactic acid bacteria such as Leuconostoc mesenteroides, Streptococcus faecalis and Pediococcus cerevisiae act on the sugars to produce lactic acid that inhibited the growth and proliferation of the indigenous flora contributed by the soaked rice. Simultaneously, Saccharomyces cerevisiae cells increased in number as it acts on sugars to produce large amount of carbon dioxide that exerted the leaving effect on the dough thus producing a spongy product. Upon addition of lye to neutralize the mixture, it is allowed undergo the second stage fermentation for approximately 5 hours. The mixture is then steamed for 30 minutes.

**Microorganisms in Puto Fermentation**

The microorganisms involved in puto fermenta-
tion increased tremendously during the 24 hour fermentation accompanied by a considerable increase in acid production. During the first stage fermentation, the dominant microorganisms were Leuconostoc mesenteroides (50%), followed by Streptococcus faecalis (39%), and Saccharomyces cerevisiae (11%). On the second stage fermentation, Leu. mesenteroides increased to 61% and S. cerevisiae to 13% while S. faecalis decreased to 22%. In addition, Pediococcus cerevisiae contributed to the 4% of the microflora of puto.

Process Improvement

An improvement of the process of making puto shortened the fermentation time to half (from 42 hrs to 20.5 hrs) with the use of starter culture consisting of the dominant microorganisms (Leu. mesenteroides, S. faecalis, and S. cerevisiae) previously isolated from the fermenting rice mixture. Another innovation is to use powdered rice as the raw material to avoid the incorporation and subsequent multiplication (during soaking) of indigenous flora in rice grains.

FERMENTED FISH (Tinabal)

The traditional fermented fish, termed as tinabal is a popular Visayan delicacy made from a species of fish locally known as molmol (Scarus spp.). This fermented fish is almost similar to fish paste except for the process of preparation (Calanoga, 1995). It has a peculiar taste or flavor different from that of the other fermented fish product like bagoong.

Preparation of Tinabal

The medium-sized fishes were washed, eviscerated and split then soaked in concentrated brine solution for 2-3 hours, drained and mixed with salt at the rate of 1:3 or 1:4 (salt : fish) by weight (Calanoga, 1995). Brined fish is packed in containers and fermented for 1-2 weeks. In commercial production, fermented fish were stored for several months since it was claimed that the longer the storage period the better is the quality of the product. The brine produced during tinabal fermentation is collected and processed into patis.

Microorganisms in Tinabal Fermentation

The microbiological examination done by Calanoga (1995) revealed that mixed type of fermentation occurred during tinabal manufacture. The predominant lactic acid bacteria consisted of Pediococcus pentosaceus and Streptococcus equinus which were found present in the mixture from zero day to 21 days fermentation. Species of Leuconostoc and Lactobacillus were also found on the ninth day of fermentation. Non-acid and proteolytic bacteria belonging to Bacillus, Staphylococcus, Pseudomonas and Alcaligenes and Debaryomyces spp. were also found in the early stage of fermentation.

FERMENTED FOODS PRODUCED BY MIXED FLORA

Some of the examples of traditional foods produced by bacterial, yeasts and molds fermentation were rice wine (tapuy), sweetened rice (binubudan) and soy sauce (toyo).

RICE WINE (Tapuy)

Rice wine commonly called tapuy is a popular traditional alcoholic drinks of the Northern part of the Luzon island specifically Banawe, Baguio City, Bontoc, and Lagawe. It is characterized as acidic but sweet aromatic alcoholic beverage. It is consumed during festivities and traditional ceremonial occasions. Similar products in other countries exist as shown in Table 1.

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>STARTER</th>
<th>WINE</th>
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<tbody>
<tr>
<td>China</td>
<td>chiu-yaw; chu; chin-piang</td>
<td>shaosing chu</td>
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<tr>
<td>India</td>
<td>bakhari; sachkwe</td>
<td>ruhi; madhu</td>
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<td>Indonesia</td>
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<td>Japan</td>
<td>koji</td>
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<td>Korea</td>
<td>nuruk magally</td>
<td>takyu; yakyu</td>
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<td>Malaysia</td>
<td>raji</td>
<td>tapai</td>
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<td>Nepal</td>
<td>marcha</td>
<td>raksi</td>
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<tr>
<td>Philippines</td>
<td>bubod; binokbok</td>
<td>tapuy</td>
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<td>Thailand</td>
<td>juk-pang; look-pang</td>
<td>nam-khao</td>
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Essentially the process involved in the production of rice wine in these countries are the same. Rice wine being prepared by traditional process is dependent on the starter culture employed and the natural flora in the environment, and therefore consisted of essential and non-essential microorganisms. Most often, this condition resulted to variable quality of the product.

**Preparation of Bubod or Binokbok**

The preparation of *bubod* or *binokbok* vary slightly in the rice wine producing area. In general however, it consists of washing and soaking of the glutinous rice overnight. The drained soaked rice is pounded until fine, mixed with onwad (wild grass) roots, ginger and enough water. The mixture is formed into ball then flattened on both sides, sprinkled on the surface with old *bubod* or *binokbok*, arranged into layers separated with dried rice straw, incubated for one day at ambient temperature (30° to 35°C) and then dried under the sun for 3 to 5 days. *Bubod* or *binokbok* is renewed after 3 months to maintain the viability of the microorganisms.

**Preparation of Rice Wine**

The preparation of rice wine vary depending on the type of rice used, namely ordinary rice, glutinous rice or combination of the two with a ratio of 50 : 50 or 20 : 80 (ordinary : glutinous) and the method of pre-treatment such as steaming or roasting (Tanimura, et al., 1978). In the Benguet and Bontoc methods the rice is washed, added with equal volume of water and steamed until half cooked while in Ifugao method, the rice is roasted until light brown and then steamed with one part roasted rice with 1.5 part water. The cooked rice is spread in bamboo trays (*bilao*) lined with green banana leaves to cool before inoculating with powdered *bubod* or *binokbok*. The mixture is allowed to undergo solid state fermentation for 3 days in a warm place then transferred to covered earthen jar to allow alcoholic fermentation for 3 to 4 weeks. Normally a bamboo basket tube is placed at the middle of the mixture allow the separation of the wine from the solid mash. After separating the liquid portion the mash is pressed to further recover the wine. The wine is later filtered and bottled before consumption.

The chemical analysis of the rice wine produced in the different areas of production revealed that the quality of the product varied (Tanimura, et al., 1978; Sanchez, et al., 1985). The soluble solids (°Brix) range from 9.8 to 18.2, pH from 3.3 to 5.0, acidity (ml/10 ml wine) from 6.7 to 20, reducing sugar from 2.5 to 6.3%, total sugar from 2.0 to 8.2%, amino nitrogen from 5.2 to 8.6 mg% and alcohol from 13.5 to 16.0 (% vol).

**Microorganisms in Rice Wine Fermentation**

The microorganisms involved in the fermentation of rice wine is influenced by the ones present in the *bubod* or *binokbok*. Viable cell count per gram of this starter culture collected from the different rice wine producing areas revealed that the mold counts ranged from $10^3$ to $10^5$, yeast from $10^4$ to $10^8$, and lactic acid bacteria from $10^4$ to $10^7$. On the other hand the viable cell count of one month-old rice wine from these localities showed that yeasts ranged from $10^3$ to $10^4$ and lactic acid bacteria from $10^7$ to $10^9$ per ml. (Sanchez, et al., 1985; Sakai and Caldo, 1985). Generally all the microorganisms present in the *bubod* were found in the rice wine except for the molds.

The dominant microorganisms present during the solid state fermentation were *Aspergillus oryzae*, *Rhizopus oryzae*, *Mucor rouxii*, *Saccharomycopsis fibuligera* and *S. capsularis* which are responsible for the saccharification of the rice starch while during the second stage of fermentation, *Saccharomyces cerevisiae*, *Lactobacillus plantarum*, and *L. cremoris* were the dominant flora responsible for the ethanol and acid production (Sanchez, 1987).

**Process Improvement**

Screening of the microorganisms isolated from the traditional process resulted in the selection of *R. oryzae*, *A. oryzae*, *S. capsularis* and *L. plantarum* for the production of amylases, lipases, proteases and organic acids while *S. cerevisiae* for the conversion of fermentable sugars to ethanol (Sanchez, et al., 1985). These strain increased the yield to 83.33% as compared 66.60% when traditional *bubod* was used.

Traditionally, waxy (glutinous) milled rice, often roasted, is used for the preparation of *tapuy*. Waxy rice command higher price relative to non-waxy rice due to limited supply and competition with other
native delicacies. Studies indicated that low-and intermediate-amylose milled rice may be used in place of waxy rice without significant change in tapuy yield and quality (Sanchez, et al., 1987).

Optimization of the process variables for solid state fermentation indicated that texture of cooked rice was affected by the length of the time of steeping before cooking which ultimately affected the saccharification (Chay, et al., 1986). The proportion of water added to rice for soaking and cooking also influenced the saccharifying rate of amylases from A. oryzae. The conversion of fermentable sugars to ethanol in the simultaneous saccharification and fermentation processes of rice mash was dependent on mold concentration, pre-saccharification time, yeast concentration and fermentation temperature.

SWEETEDED RICE (Binubudan)

This product is prepared by inoculating bubod to the cooked rice. It is allowed to ferment for 24 hours at ambient temperature (28°C to 30°C) before consumption. The product has sweet and alcoholic taste.

SOY SAUCE (Toyo)

Soy sauce or toyo is dark-brown liquid hydrolyzate of fermented soybeans. It has a characteristic aroma and salty taste that enhance the flavor of the food where it is incorporated. This product is known to have originated in Asia and have spread to many countries around the world. A typical fermented soy sauce contains 1.0-1.54% of total organic acids, mainly the glutamic acid.

Preparation of Toyo

Traditionally, toyo is prepared from whole soybeans soaked overnight, cooked for one hour under pressure, inoculated with moldy rice from the previous batch of preparation, coated with toasted wheat flour, spread as thin layer in bamboo trays and held at 30°C for 3 days at high humidity to permit mold growth. The resulting material is mixed with 18% brine solution in a deep vessel to undergo the second stage fermentation. This anaerobic brine fermentation stage involves the indigenous bacteria (mostly lactic acid bacteria) and yeasts. After fermentation for one month or one year, the dark brown salty liquid is pressed-out from the fermenting mash, filtered, clarified, and packaged for distribution.

Microorganisms in Toyo Fermentation

The employment of the moldy rice from the previous batch as inoculum encouraged the development of many microbes in the mixture but due to the condition provided, mostly of the non-essential microorganisms were inhibited and instead Aspergillus oryzae predominated. Similarly, the intermittent mixing of the fermentation mash provided enough aeration for this mold to have proliferous growth but discourage early sporulation. Upon addition of brine solution and providing anaerobic condition, vigorous growth of lactic acid bacteria (Lactobacillus delbrueckii and Pediococcus halophilus) and yeasts (Saccharomycopsis rouxii and Zygosaccharomyces sojae) is induced resulting to the drop of pH from 6.0 to 4.5. This resulting pH inhibited spoilage microorganisms. Yeast Fermentation led to the production of small amount of ethanol (1-2%) and the development of the typical soy sauce aroma.

CONCLUSION

The different traditional fermented foods in the Philippines are briefly discussed together with the processes of their manufacture and the associated microorganisms responsible for their production. For details, it is recommended that the original papers be consulted.

References