Additional Comments on Traditional Fermented Foods

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In this roundtable I would like to discuss a few important points about traditional fermented protein foods which I could not have time to describe in the plenary session paper.

First, I would like to describe in more detail the recent progress in making soy sauce in Japan. During the last two decades, there were several revolutionary changes in soy sauce technology in Japan. As a result, the yield and quality of soy sauce have improved markedly. Among these changes, the most important ones are improvement of the treating method for soybeans and development of the new automatic koji-making system. Improvement of the treating method is based upon the findings that the degree of the hydrolysis of soybean proteins by the proteases of *Aspergillus* species is greatly influenced by cooking conditions. The relationship between cooking conditions and yields of soy sauce are shown in Table I.

As shown in this table, the higher the pressure, that is, the higher the temperature, the higher the yields become, whereas the longer the time, the lower the yields. The total nitrogen and the amino nitrogen increase with increased yields. Furthermore, the development of new, automatic koji-making equipment that I showed in the plenary session enabled us to make koji under such conditions that the production of the enzymes in koji may become a maximum. In the past, koji was made in small wooden trays. By this wooden tray method, we cannot control the temperature and humidity to maximize enzyme production. Comparison between a wooden tray and an automatic equipment method is shown in Table II. Application of the automatic koji-making system to soy sauce production not only makes the protease activity of koji increase, but also it prevents koji from infection by undesirable microorganisms which give soy sauce unfavorable odor. As a result, a high quality soy sauce with plenty of favorable aroma can be produced consistently.

In another area, we have made clear the role of the various microorganisms during brine fermentation. Using this knowledge, a new method to control the microorganisms of the moromi mash has been developed. This method includes the addition of salt plus pure culture, preferable lactic acid bacteria, and salt resistant yeasts to moromi mash.

Also, I would like to refer briefly to the question of mycotoxins. It has been ascertained that no *Aspergillus* species used in the food industries in Japan do not produce aflatoxins. Checks on so called mycotoxins, such as aspergillic acid, kojic acid, β-nitro-propionic acid, oxalic acid, and formic acid, have also been carried out on the Aspergilli which are widely used in Japanese industries. In detailed results of the experiments, it has been made clear that the Aspergilli examined in Japan present no problems for food making with regard to these so called mycotoxins (2).

Finally, I would like to comment on characteristic flavor of traditional fermented protein foods. Traditional foods are closely related to the regional food cultures and, therefore, some of their flavor might be felt unacceptable for the people who are not in these food cultures. However, these traditional foods are the products which had been developed through thousands of years and had been selected through long experience. Thus, these flavors would be acceptable eventually for most of the people, even though unacceptable at the first taste trial. For instance, Kikkoman Shoyu Company in Japan had been exporting koikuchi-shoyu, that is, Japanese style of soy sauce, to the U.S. since 1868, when Japanese first immigrated into the U.S. This export was just for Japanese Americans until World War II. After World War II, however, we changed the market target from Japanese Americans to the American population as a whole. Now, Japanese style of soy sauce has been accepted by most American people. Therefore, we constructed a soy sauce manufacturing plant in the U.S. five years ago. Thus, the Japanese style of soy sauce has been averaging a 15% increase annually in America. The steady penetration of

TABLE I

Relationship between Cooking Conditions and Yields of Soy Sauce

Cooking Conditions			Chemical analysis of resultant soy sauce			
Pressure (kg/cm^2)	Temperature (C)	Time (min)	NaCl (g/100ml)	Total nitrogen (g/100ml)	Amino nitrogen (g/100ml)	Yield[a] (%)
0.9	118	45	17.40	1.653	0.817	82.05
2.0	132	5	17.40	1.697	0.837	84.24
6.7	151	2	17.40	1.752	0.839	86.87
7.0	170	0.25	17.40	1.778	0.878	88.26

[a]The yields are expressed by % of the hydrolyzed nitrogen against the total nitrogen which is contained in the materials.

TABLE II

Comparison of Protease Activity of Koji and Yields of Resultant Soy Sauce between Wooden Tray and Automatic Equipment Method (1)

	Activity of proteases of koji (Unit)	Yield of soy sauce (%)
Wooden tray method	28.40	75.0
Automatic equipment method	40.53	81.0

Japanese style of soy sauce to the American population might be proof that a traditional fermented flavor in one area can also be accepted by most of the people in another area. It might be presumed that most of the traditional protein foods could be accepted by most of the people in the world, to the extent that the qualities are superior. When we consider the development and popularization of vegetable protein foods, it might be of great importance that we have a further look at the traditional protein foods from this point of view, examine them in detail by modern scientific methods, and develop some new food technology based on these traditional products.

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Fermented Foods of Southeast Asia

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Toxin produced by *Pseudomonas cocovenenans* are bongkrek acid, which is colorless, and toxoflavin, which has a yellow color. Bongkrek acid is responsible for deadly food poisoning which, until recently, claimed victims in Indonesia.

A lethal dose of bongkrek acid is 2 mg/100 g body weight. This dose will kill mice within 2-5 hr, if injected intraperitoneally. Doses of 1 mg/100 g body weight will not kill mice unless the doses are repeated within 40 hr. This is an indication that the BA has cumulative action. Eating bongkrek in small amounts is also still very dangerous for human beings.

Berends et al. have succeded in showing that bongkrek acid acts as an inhibitor to oxidative phosphorylation in mitochondria. In consequence, the ATP production in mitochondria will be disturbed. If it attacks heart muscle cells, the heart will stop due to lack of ATP.

Symptoms of bongkrek poisoning in mice are the same as in human beings. In the very beginning, people suffer from hyperglycemia. Later step-by-step this changes into hypoglycemia and the victim dies due to hypoglycemia. The patient will also suffer acidosis due to rapid lactic acid production in the blood.

Toxoflavin is also dangerous. According to the literature, toxoflavin functions as an electron transport carrier, which bypasses the cytochrome system. The end product of this process is production of hydrogen peroxide which, in fact, is very toxic to the cell. However, cells having abundance of catalase apparently will survive.

Coconut presscake inoculated with *Ps cocovenenans* and incubated at room temperature for five days will become a yellow-brownish color. This was dried and extracted using petroleum ether as solvent and shaken with 2% bicarbonate. A sample kept in 2% Na bicarbonate can last a few months if refrigerated.

Some of the local governments in Central Java have banned the making and selling of tempeh bongkrek. However, since many people are so attached to this particular fermented food, and making tempeh bongkrek is the only source of their income, this particular regulation creates problems. The tempeh bongkrek-making continues underground or illegally.

Using calingcing leaves (*Oxalis sepium*) during the making of bongkrek may help in reducing toxic poisoning. Local people still have not accepted this due to the flavor produced. The future use of NaCl for inhibiting *Ps cocovenenans* has very good prospects since NaCl will certainly be part of the food in the end.

Other Fermented Foods

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In my plenary paper, I did not have time to complete all I wanted to say about the Kaffir beer fermentation. It is also called Bantu beer, and there are some other names. One of the things that I think interesting is that the average cost per pack of Kaffir beer in wax-lined cardboard packages was 15 cents per liter, and for bulk beer it is 10 cents per liter. There are ca. 900 million liters of Bantu beer produced per year, and that bulk beer is declining in volume while the packaged beer that is in the cardboard packages is increasing. The price of the beer is only about half the price of milk or Coca Cola.

I should tell you about the actual production of beer in South Africa. Some plants have a capacity of 4.5 million gallons per month production. As a matter of fact, if you look at the number of breweries in South Africa, there are three large breweries with an annual production of at least 17 million imperial gallons each. There are also 16 breweries with an annual capacity of 1 to 7 million imperial gallons, and there are 50 minor producers who annually produce less than 1 million imperial gallons. Industrialization of the fermentation has only recently happened. The original work that was done in South Africa began in 1954, and in that short period of time the production has gone up tremendously as the figures would indicate.

The Bantu industry, of course, is unique in several aspects. It is a large, modern, industrial fermentation founded on tribal art. The industry also is in the hands of the local authorities and not private industry. Another interesting thing is the profits are controlled by the government, and the greatest amount of profit goes for Bantu development projects. And also it is partly privately financed in that the sorghum malt and the yeast inoculum are made by private industry and sold to the municipal breweries. In 1966, the municipal breweries bought about a quarter of a million pounds of dried yeast for pitching, that is, for inoculation. This is all private industrial work. Also, it is unique in that the government takes out of each gallon of sales 3/4 of a cent which goes back into financing research on the production of Bantu beer.

Now the question comes up of how many companies or