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Indigenous Fermented Food of Non-Western Origin

Edited by

C. W. HESSELTINE AND HWA L. WANG

J. CRAMER
in der Gebrüder Borntraeger Verlagsbuchhandlung
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DEDICATION

To all of the research scientists and interested persons who have contributed to our knowledge of fermented foods in the World

CONTENTS

Acknowledgment

We thank the editors and publisher of the abstracts of the papers presented at the Sixth International Fermentation Symposium in 1980 for permission to use some of the data presented in abstract form. This material was expanded for certain chapters in this publication from the abstracts published by Pergamon Press, Inc.

Preface

Preparation of foods by the use of microorganisms predates the recorded history of man. They probably originated from chance observations in which a set of environmental conditions prevailed and an acceptable food product resulted. The process was repeated and soon a set of steps and conditions were followed which led to a desired product. This was then handed down from one generation to the next. Products with moisture were ones in which bacteria and yeast grew and these organisms are still the ones used in a liquid or semiliquid fermentation medium. Milk fermentations are bacterial in nature whereas a drier substrate such as soybeans or rice promotes mold growth and these are the products today which are made with molds such as koji and tempeh.

Fermented foods still play a prominent role in the diet of millions of people both in the West and in the rest of the world. Methods by which typical Western foods are prepared by fermentation are well documented in the literature and it is not our intent to deal with these. However, millions of people in Africa and Asia depend upon fermented foods for their existence. A few foods of these areas have been studied extensively and much is known about substrate preparations, types of microorganisms involved, fermentation conditions, enzymatic changes, and nutritional values. Examples are kaffir beer of South Africa and shoyu of Japan. However, there is no book published which covers these non-Western fermented foods and most foods from this area prepared by fermentation are poorly reported and, if so, often in obscure publications not readily available to most scientists.

At the Sixth International Fermentation Symposium held in 1980 at London, Canada, we were able to organize sessions dealing with the broad aspects of fermented foods indigenous to the non-Western world. Besides these papers we were able to obtain some additional manuscripts dealing with the subject. This book is made up of the manuscripts from these two sources. In addition, we have been compiling a

list of little-known or unique fermented products for many years. Accordingly, we have prepared a glossary describing some of them and the source of our information. Actually, this is a supplement to the list prepared by one of us in 1965 (Mycologia **57:** 149-197).

We hope that this text will serve as an important reference for contemporary food scientists and technologists, microbiologists, nutritionists, and food fermentologists interested in the little-known fermented foods of the non-Western world. An added reason for this book is the rapidly growing interest and production of foods by fermentation from the Far East in the U.S. and Europe.

Chapter 1

Food Fermentation Research and Development

by

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In the last 20 years, considerable interest has developed in the West in learning the ways employed by non-Western peoples in the use of microorganisms to prepare attractive, nutritious, and highly acceptable foods from legumes and cereals. This has occurred in the West, at least in the United States, for several reasons. One is the interest in the export of agricultural commodities to importing countries which use the commodity in the preparation of traditional foods made by fermentation. Studies on fermented foods at the Northern Regional Research Center were initiated to better understand how U.S. soybeans were used in making the Japanese product, miso (Hesseltine and Shibasaki **1961,** Shibasaki and Hesseltine **1961a, 1961b**). A second reason is the concern of many people about the nutritional value of foods, and especially the realization that vegetable proteins and oils have great merit as foods. Thirdly, there is an interest in the activities of microorganisms used in food fermentations. The industrial use of fungal enzymes was introduced from the koji process used in making sake and shoyu, in which fungal amylases and proteases play an important role. It is apparent that, besides these enzymes, other secondary products are produced, and some constituents of the substrate are either destroyed or modified. Fourthly, and to a lesser extent, there has been an interest in the bacteria, yeasts, and molds selected through the centuries for making a specific product. *Amylomyces,* a mucoraceous genus, is not known to occur anywhere in the world except in the starter cultures used in food fermentations in China, Indonesia, and the Far West (Ellis *et al.* **1976**). Fifthly, students from areas where microorganisms are used in preparation of traditional foods have used these processes as research topics during their stay in the West.

Because of these trends, a variety of scientific disciplines have been involved in studies on fermented foods, including food scientists,

biochemists, bacteriologists, mycologists, anthropologists, enzymologists, nutritionists, and chemists. Consequently, publications are scattered in various abstracted journals, including such diverse ones as *Journal of Food Science, Applied and Environmental Microbiology, Agricultural and Biological Chemistry, Mycologia, Journal of Science of Food and Agriculture,* and *Economic Botany.* Moreover, literature often appears in provincial publications, institute reports that are in other than the English language, trade journals such as *Soy Foods,* and proceedings of regional conferences devoted to broader topics than just fermented foods. Likewise, some information appears in nonscientific literature such as newspapers, correspondence, and travel reports.

Since no book is available in English or any other language on this subject at this writing, we believe that a modest book on this subject is justified. Recently four meetings have dealt with research on fermented foods. The first was the Fifth International Conference on Global Impacts of Applied Microbiology at Bangkok, Thailand, in 1977, but the papers were not published. The second was a 1979 International Symposium on Oriental Fermented Foods held in Taipei, Taiwan, for which a Proceedings was published in 1980. The third was the International Symposium on Microbiological Aspects of Food Storage, Processing and Fermentation in Tropical Asia, held at Bogor Agricultural University in 1979; the proceedings was multilithed but not edited. The fourth was the Fermentation Symposium held in 1980 in London, Canada, which devoted several sessions to fermented foods.

It is surprising that so little has been written on the subject in view of the amounts of fermented foods consumed in the non-Western world. For example, data from Dr. H. Ebine (personal communication) of the Food Research Institute in Japan, citing data from The Japanese Food Agency of the Ministry of Agriculture, Forestry and Fisheries, states that 567,776 tons of miso, 1,252,431 kiloliters of shoyu, and 158,000 tons of natto were produced in 1979 in Japan, which has a population of about 114 million (1977 figure). If we consider similar food consumption figures for China, with a population of 866 million, then these numbers are nearly eight times greater. Although we know of no figures on fermented food consumption of India and adjacent countries, where the population in 1977 was 882 million, let us estimate that the figure for fermented foods amounts to 10 kilograms per person, or a total of 8,820 million kilograms. According to Yu and Pyun (**1980**), 51,237 metric tons of soybean paste, 97,830 kiloliters of soy sauce, and 33,525 metric tons of gochoojang (hot pepper paste) were produced in Korea in 1978. In 1977 in Thailand (Bhumiratana **1980**), 120,000,000 liters of nam-pla (fish sauce) was produced and production is rapidly

increasing. From these examples, and there are many others, it is apparent that the production of a number of these products is quite large. Additionally, some of these products are important from the standpoint of health of the people. For example, vegetarian diets need added vitamin B12, and the only source is that produced by bacteria. Nonvegetarians get B12 from meat they eat, which, in turn, originated from bacteria.

Another reason for considering fermented foods is the recent interest in the West for more natural foods prepared in old traditional ways. For example, the Soycrafters Association of North America has estimated that the total retail sales of tofu amount to 49,790,000 pounds, with a retail value of $44,811,000 in the U.S. and Canada, with 147 U.S. production units. Tempeh, produced by 30 units, amounts to 926,640 pounds, with a retail value of $1,667,952. Nine factories in the United States and two in Canada produce miso; the largest reportedly produces about 1,000,000 pounds of miso per year. An interesting aspect of this rapidly growing business in the U.S. is the fact that the traditional Asian processes using soybeans are simple and can be made by persons with little training. Also the equipment, such as cooling water tanks, is already available from the dairy equipment manufacturers at reasonable prices.

We should be interested in some of the fermented food products because the commodities used in the foods are produced in the United States and exported to those countries that make fermented products from them. According to the *Washington Farmletter,* February 6, 1981 (Anon. **1981**), we export 6,16 billion dollars worth of soybeans, 6,55 billion dollars worth of wheat and wheat flour, and 1,17 billion dollars worth of rice. Japan alone buys 5.7 billion dollars worth of agricultural products. Agricultural products purchased by two other countries that make large quantities of fermented foods amount to 1,94 billion dollars for China and 1.6 billion dollars for South Korea. Rice, wheat, and soybeans are singled out above because they are widely used in making miso, and soybeans provide the protein source for natto and shoyu. The shoyu process also uses wheat. It is important to understand how those buying these products use them in fermentation, what problems they have with the products, what characteristics they would like to see in the commodity, and what can be done to improve the process.

Initial work in our Fermentation Laboratory was devoted to a study of the miso fermentation. As soon as the process and the nature of the food was understood, it was obvious that there were problems, such as the pigment about the hilum of some varieties of soybeans, the lack of uniformity in absorption of water, and the lack of uniform cooking to

facilitate mashing of the soybeans. A problem still remains in the export market, in that the miso companies prefer to buy Chinese beans instead of U.S. beans because they claim that Chinese beans make better miso. Some factors, such as the color and the size of the bean, are not important in shoyu making because defatted soy flakes are used for the fermentation. Among our accomplishments in dealing with the Japanese soybean fermentation was the discovery that *Saccharomyces rouxii* (Wickerham and Burton **1960**) is heterothallic and, therefore, can be bred to make better strains to be used in high-salt fermentations, to grow faster and produce better flavor. It was apparent that pure cultures of vigorously growing bacteria and yeasts should be used in the miso fermentation to give a reproducible product and a shorter fermentation time rather than using miso paste as a starter. This practice of pure culture inoculum is now widely used in Japan. Another example was the work we did on the tempeh fermentation of Indonesia. We found that the flat soybean cakes could be readily fermented when cakepans were the fermentation vessel. Plastic perforated sheets were used as the covers (Martinelli and Hesseltine **1964**), allowing the entry of oxygen into the fermenting soybean mass. The native procedure was to ferment the soybeans wrapped in banana leaves. Much of Indonesia's tempeh now sold is fermented as cakes in plastic bags, and the product is sold by cutting out blocks of tempeh to the size desired by the customer. Thus, with the package open at the sides but the bottom and top still covered with the plastic film in which the tempeh was made, the customer can examine the degree of development of the mold and the odor of the product but still gets the tempeh cake partially protected with cellophane. These are some of the ways in which our research has been transferred to countries where our commodities are used.

The matter of communication between workers in the field of fermented foods has been a problem. No journal is devoted exclusively to the subject. The transfer of technology for making tempeh in plastic containers came about pretty much by chance. Our studies on tempeh were supported by UNICEF and were intended for promotion of this food in South America. As far as we are aware, the use of tempeh never developed there. However, some alert Indonesian scientists, who were sent our publications describing tempeh made in plastic containers, saw possibilities for the process in Indonesia. Through workshops, the process was introduced to the Indonesian tempeh makers. As soon as some of the makers had successfully processed tempeh in plastic containers and were selling the better, cleaner, more attractively packaged product, other makers were forced by competition to accept the method. We have been told that 90% of the tempeh in Indonesia now is prepared in this manner.