

13 Indigenous Fermented Foods

LARRY R. BEUCHAT

Griffin, GA 30223-1797, USA

- 1 Introduction 507
- 2 Fermented Foods of the Orient 507
 - 2.1 Soy Sauce 507
 - 2.1.1 Preparation of Soybeans 513
 - 2.1.2 Preparation of Wheat 515
 - 2.1.3 Koji Process 515
 - 2.1.4 Mash (Moromi) Stage 516
 - 2.1.5 Pasteurization 517
 - 2.2 Miso 518
 - 2.2.1 Preparation of Koji 518
 - 2.2.2 Preparation of Soybeans 520
 - 2.2.3 Fermentation and Aging 520
 - 2.2.4 Modified Indigenous Procedures 521
 - 2.3 Fermented Whole Soybeans (Natto Products) 522
 - 2.4 Sufu 523
 - 2.5 Meitauza 525
 - 2.6 Lao-chao 525
 - 2.7 Ang-kak 525
 - 2.8 Puto 527
 - 2.9 Ragi 528
 - 2.10 Tapé 528
 - 2.11 Tempeh 529
 - 2.11.1 Preparation of Soybeans and Fermentation 529
 - 2.11.2 Biochemical Changes 531
 - 2.11.3 Nutritional Characteristics 533
 - 2.12 Oncom 533
 - 2.12.1 Preparation of Peanuts and Fermentation 534
 - 2.12.2 Biochemical Changes 535
 - 2.13 Fish Products 536
 - 2.13.1 Nuoc-mam 536
 - 2.13.2 Bagoong 537

506	<i>13 Indigenous Fermented Foods</i>
	2.13.3 Prahoc 537
	2.13.4 Phaak 537
	2.13.5 Katsuobushi 537
	2.14 Kimchi 537
3	Fermented Foods of India 538
	3.1 Idli 538
	3.2 Waries 540
	3.3 Papadam 540
	3.4 Dhokla 540
	3.5 Khaman 540
	3.6 Kenima 540
	3.7 Jalebies 541
	3.8 Kurdi 541
	3.9 Kanji 541
4	Fermented Foods of Africa 542
	4.1 Dawadawa 542
	4.2 Gari 543
	4.3 Banku 544
	4.4 Ogi 545
	4.5 Injera 546
	4.6 Kaffir Beer 546
	4.7 Merissa 547
5	Other Fermented Products 547
	5.1 Milk/Grain Products 547
	5.1.1 Kushik 547
	5.1.2 Tarhana 547
	5.1.3 Kishk 547
	5.2 Kaanga-kopuwai 548
	5.3 Poi 548
	5.4 Chicha 548
	5.5 Pozol 549
	5.6 Legume-Based Milk Products 549
6	Nutritional and Public Health Aspects 551
7	References 552

1 Introduction

Fermented foods, whether from plant or animal origin, are an intricate part of the diet of people in all parts of the world. It is the diversity of raw materials used as substrates, methods of preparation and sensory qualities of finished products that are so astounding as one begins to learn more about the eating habits of various cultures. The preparation of many indigenous or "traditional" fermented foods and beverages remains today as a household art. The preparation of others, e.g., soy sauce, has evolved to a biotechnological state and is carried out on a large commercial scale.

It will not be the objective of this chapter to review in detail or even to introduce the reader to the many hundreds of indigenous fermented foods eaten daily. Space does not permit a detailed account and, besides, we know very little or nothing about the biochemistry and microbiology of many of these foods. Fermented vegetables, dairy products and beverages will be covered in considerable detail in other chapters in this volume. Tab. 1 lists some of the more common indigenous fermented foods consumed in various parts of the world. Many of these are discussed in the following text which, out of need for some degree of organized approach, has been divided according to the areas of the world in which they are most likely to be prepared and consumed.

Several books (HESSELTINE and WANG, 1986; REDDY et al., 1986; STEINKRAUS, 1983; WOOD, 1985) and reviews (BEUCHAT, 1987; CAMPBELL-PLATT and COOK, 1989; CHAVAN and KADAM, 1989; NOUT and ROMBOUTS, 1990; SANNI, 1993) have been published on the subject of indigenous fermented foods. A book describing applications of biotechnology to traditional fermented foods was published by the U.S. National Research Council (RUSKIN, 1992). A dictionary and guide to fermented foods of the world (CAMPBELL-PLATT, 1987) and a glossary of indigenous fermented foods (WANG and HESSELTINE, 1986) provide excellent descriptions of known biochemical and microbiological processes associated with indigenous food

fermentations. The reader is encouraged to consult these and other publications cited in the following text for more detailed descriptions of fermented foods.

2 Fermented Foods of the Orient

2.1 Soy Sauce

The written records of the Chinese show that they have been using soy sauce for over three thousand years (YONG and WOOD, 1974). Production of soy sauce in Japan probably was a result of the introduction of Buddhism from China and the consequent change to a vegetable diet in 552 A.D. (HESSELTINE, 1965). SMITH (1961) published a report on various methods of using soybeans as foods, including soy sauce, in China, Japan, and Korea. YOKOTSUKA (1960), YONG and WOOD (1974) and HESSELTINE (1983) have subsequently reviewed soy sauce fermentation in considerable detail. The technology of soy sauce preparation was at one time a closely guarded family art passed on from one generation to the next. While there are still unique formulae used on a domestic level, the major steps involved in the manufacture of soy sauce are no longer a secret. There is, however, much to be learned about the biochemical changes which occur during fermentation and lead to desirable as well as undesirable sensory qualities in the finished product.

Two distinct basic processes can be used to prepare soy sauce (BEUCHAT, 1984). The first involves fermentation with microorganisms and the second, i.e., chemical method, involves the use of acids to promote hydrolysis of ingredient constituents. The latter method will not be discussed here mainly because it cannot be considered as traditional or indigenous, but also because there are many who consider the end product to be inferior and not in a class deserving of recognition as a substitute for the fermented product. Further-

Tab. 1. Indigenous Fermented Foods^a

Product	Geography	Substrate	Microorganism(s)	Nature of Product	Product Use
Ang-kak (anka, red rice)	China, Southeast Asia, Syria	Rice	<i>Monascus purpureus</i>	Dry red powder	Colorant
Bagoong	Philippines	Fish	Unknown	Paste	Seasoning agent
Bagni	Caucasus	Millet	Unknown	Liquid	Drink
Banku	Ghana	Maize, cassava	Lactic acid bacteria, yeasts	Dough	Staple
Bonkre	Central Java (Indonesia)	Coconut press cake	<i>Rhizopus oligosporus</i>	Solid	Roasted or fried in oil, used as a meat substitute
Bouza	Egypt	Wheat	Unknown	Liquid	Thick acidic
Fraga	Romania	Millet	Unknown	Liquid	Drink
Burukutu	Savannah regions of Nigeria	Sorghum and cassava	Lactic acid bacteria, <i>Candida</i> spp., <i>Saccharomyces cerevisiae</i>	Liquid	Creamy drink with suspended solids
Busa	Tartars of Krim, Turkistan, Egypt	Rice or millet, sugar	<i>Lactobacillus</i> and <i>Saccharomyces</i>	Liquid	Drink
Chee-fan	China	Soybean wheat curd	<i>Mucor</i> sp., <i>Aspergillus glaucus</i>	Solid	Eaten fresh, cheese-like
Chicha	Peru	Maize	<i>Aspergillus, Penicillium</i> spp., yeasts, bacteria	Spongy	Eaten with vegetables
Chichwangu	Congo	Cassava roots	Bacteria	Paste	Staple
Chinese yeast	China	Soybeans	Mucoraceous molds and yeasts	Solid	Eaten fresh or canned, used as a side dish with rice
Darassum	Mongolia	Millet	Unknown	Liquid	Drink
Dawadawa (daddowa, uri, kpalugu, kinda)	West Africa, Nigeria	African locust bean	Lactic acid bacteria, yeasts	Solid, sun-dried	Eaten fresh, supplement to soups, stews
Dhokla	India	Bengal gram and wheat	Unknown	Spongy	Condiment
Dosai (doza)	India	Black gram and rice	Yeasts, <i>Leuconostoc mesenteroides</i>	Spongy, pancake-like	Breakfast food
Fish sauce (nuoc-mam, patis, mam-pla, ngam-pya-ye)	Southeast Asia	Fish	Bacteria	Liquid	Seasoning agent

Gari	West Africa	Cassava root	<i>Corynebacterium manihot</i> , <i>Geotrichum candidum</i>	Wet paste	Eaten fresh as staple with stews, vegetables
Hamanatto	Japan	Whole soybeans, wheat flour	<i>Aspergillus oryzae</i> , <i>Streptococcus</i> , <i>Pedococcus</i>	Beans retain individual form, raisin-like, soft	Flavoring agent for meat and fish, eaten as snack
Idli	Southern India	Rice and black gram	Lactic bacteria (<i>Leuconostoc mesenteroides</i> , <i>Torulopsis candida</i> and <i>Trichosporon pullulans</i>) <i>Candida guilliermondii</i>	Spongy, moist	Bread substitute
Injera	Ethiopia	Teff, or maize wheat, barley, sorghum	<i>Saccharomyces bayanus</i>	Bread-like, moist	Bread substitute
Jalebies	India, Nepal, Pakistan	Wheat flour		Pretzel-like, syrup filled	Confection
Jamin-bang	Brazil	Maize	Yeasts and bacteria	Bread or cake-like	Bread substitute
Kaanga-kopuwai	New Zealand	Maize	Bacteria and yeasts	Soft, slimy	Eaten as vegetable
Kanji	India	Rice and carrots	<i>Hansenula anomala</i>	Liquid	Sour, added to vegetables
Katsuobushi	Japan	Whole fish	<i>Aspergillus glaucus</i>	Solid, dry	Seasoning agent
Kecap	Indonesia and vicinity	Soybeans, wheat	<i>Aspergillus oryzae</i> , <i>Lactobacillus</i> , <i>Hansenula</i> , <i>Saccharomyces</i>	Liquid	Condiment, seasoning agent
Kenim	Nepal, Sikkim, Darjeeling district of India	Soybeans	Unknown	Solid	Snack
Kenkey	Ghana	Maize	Unknown	Mush	Steamed, eaten with vegetables
Ketjap	Indonesia	Black soybeans	<i>Aspergillus oryzae</i>	Syrup	Seasoning agent
Khaman	India	Bengal gram	Unknown	Solid, cake-like	Breakfast food
Kimchi (kim-chee)	Korea	Vegetables, sometimes seafoods, nuts	Lactic acid bacteria	Solid and liquid	Condiment
Kishk (kushuk, kushik)	Egypt, Syria, Arab world	Wheat, milk	Lactic acid bacteria, <i>Bacillus</i> spp.	Solid	Dried balls dispersed rapidly in water
Lafun	West Africa, Nigeria	Cassava root	Bacteria	Paste	Staple food
Lao-chao	China, Indonesia	Rice	<i>Rhizopus oryzae</i> , <i>R. chinensis</i> , <i>Chlamydomucor oryzae</i> , <i>Saccharomyopsis</i> sp.	Soft, juicy, glutinous	Eaten as such as dessert or combined with eggs, seafood

Tab. 1. Indigenous Fermented Foods^a (Continued)

Product	Geography	Substrate	Microorganism(s)	Nature of Product	Product Use
Mahewu (Magou)	South Africa	Maize	Lactic acid bacteria (<i>Lactobacillus delbrueckii</i>)	Liquid	Drink, sour and non-alcoholic
Meitauza	China, Taiwan	Soybean cake	<i>Actinomyces elegans</i>	Solid	Fried in oil or cooked with vegetables
Meju	Korea	Soybeans	<i>Aspergillus oryzae</i> , <i>Rhizopus</i> spp.	Paste	Seasoning agent
Merissa	Sudan	Sorghum	<i>Saccharomyces</i> sp.	Liquid	Drink
Minchin	China	Wheat gluten	<i>Paecilomyces</i> , <i>Aspergillus</i> , <i>Cladosporium</i> , <i>Fusarium</i> , <i>Syncephalastum</i> , <i>Penicillium</i> , <i>Tricothecium</i> spp.	Solid	Condiment
Miso (chiang, jang, doenjang, taucu, tao chieo)	Japan, China	Rice and soybeans or rice and other cereals such as barley	<i>Aspergillus oryzae</i> , <i>Torulopsis etchellsii</i> , <i>Lactobacillus</i>	Paste	Soup base, seasoning
Munkoyo	Africa	Millet, maize or kaffir corn plus roots of munkoyo	Unknown	Liquid	Drink
Nan (khab-z)	India, Pakistan, Afghanistan, Iran	Unbleached wheat flour	Unknown	Solid	Snack
Natto	Northern Japan	Soybeans	<i>Bacillus natto</i>	Solid	Cake, as a meat substitute
Ogi	Nigeria, West Africa	Maize	Lactic bacteria (<i>Cephalosporium</i> , <i>Fusarium</i> , <i>Aspergillus</i> , <i>Penicillium</i> spp., <i>Saccharomyces cerevisiae</i> , <i>Candida mycoderma</i> (<i>C. valida</i> or <i>C. vini</i>))	Paste	Staple, eaten for breakfast, weaning babies
Oncom (ontjom, lontjom)	Indonesia	Peanut press cake	<i>Neurospora intermedia</i> , less often <i>Rhizopus oligosporus</i>	Solid	Roasted or fried in oil, used as meat substitute
Papadam	India	Black gram	<i>Saccharomyces</i> spp.	Solid, crisp	Condiment
Peujeum	Java	Banana, plantain	Unknown	Solid	Eaten fresh or fried

Pito	Nigeria	Guineacorn or maize or both	Unknown	Liquid	Drink
Poi	Hawaii	Taro corms	<i>Lactobacillus</i> bacteria, <i>Candida vini</i> (<i>Mycoderma vini</i>), <i>Geotrichum candidum</i>	Semi-solid	Side dish with fish, meat
Pozol	Southeastern Mexico	Maize	Molds, yeasts, bacteria	Dough, spongy	Diluted with water, drunk as basic food
Prahoc	Cambodia	Fish	Unknown	Paste	Seasoning agent
Puto	Philippines	Rice	Lactic acid bacteria, <i>Saccharomyces cerevisiae</i>	Solid	Snack
Rabdi	India	Maize and buttermilk	Unknown	Semi-solid	Mush, eaten with vegetables
Sierra rice	Ecuador	Unhusked rice	<i>Aspergillus flavus</i> , <i>A. candidus</i> , <i>Bacillus subtilis</i>	Solid	Brownish-yellow, seasoning
Sorghum beer (Ibantu beer, kaffir beer, leting, joala, utshivala, mqomboti, igwetele)	South Africa	Sorghum, maize	Lactic acid bacteria, yeasts	Liquid	Drink, acidic and weakly alcoholic
Soybean milk	China, Japan	Soybeans	Lactic acid bacteria	Liquid	Drink
Soy sauce (Chaing-yu, shoyu, toyo, kang-jang, kecap, seeieu)	Japan, China, Philippines, other parts of Orient	Soybeans and wheat	<i>Aspergillus oryzae</i> or <i>A. soyae</i> , <i>Lactobacillus</i> bacteria, <i>Zygosaccharomyces rouxii</i>	Liquid	Seasoning for meat, fish, cereals, vegetables
Sufu (tahur, taokaan, tao-hu-yi)	China, Taiwan	Soybean whey curd	<i>Actinomyces elegans</i> , <i>Mucor hiemalis</i> , <i>M. silvaticus</i> , <i>M. subtilissimus</i>	Solid	Soybean cheese, condiment
Tao-si	Philippines	Soybeans plus wheat flour	<i>Aspergillus oryzae</i>	Semi-solid	Seasoning agent
Taotjo	East Indies	Soybeans plus roasted wheat meal or glutinous rice	<i>Aspergillus oryzae</i>	Semi-solid	Condiment

Tab. 1. Indigenous Fermented Foods* (Continued)

Product	Geography	Substrate	Microorganism(s)	Nature of Product	Product Use
Tapé	Indonesia and vicinity	Cassava or rice	<i>Saccharomyces cerevisiae</i> , <i>Hansenula anomala</i> , <i>Rhizopus oryzae</i> , <i>Chlamydomucor oryzae</i> , <i>Mucor</i> sp., <i>Endomycopsis fibuliger</i> (<i>Saccharomycopsis</i> sp.)	Soft solid	Eaten fresh as staple
Tarhana	Turkey	Parboiled wheat meal and yoghurt (2:1)	Lactic acid bacteria	Solid powder	Dried seasoning for soups Drink
Tauco	West Java (Indonesia)	Soybeans, cereals	<i>Rhizopus oligosporus</i> , <i>Aspergillus oryzae</i>	Liquid	Fried in oil, roasted, or used as meat substitute in soup
Tempeh (tempe kedede)	Indonesia and vicinity, Surinam	Soybeans	<i>Rhizopus</i> spp., principally <i>R. oligosporus</i>	Solid	Drink, mildly alcoholic
Thumba (bojah)	West Bengal	Millet	<i>Endomycopsis fibuliger</i>	Liquid	Seasoning for vegetables
Torani	India	Rice	<i>Hansenula anomala</i> , <i>Candida guilliermondii</i> , <i>C. tropicalis</i> , <i>Geotrichum candidum</i>	Liquid	
Waries	India	Black gram flour	<i>Candida</i> spp., <i>Saccharomyces</i> spp.	Spongy	Spicy condiment eaten with vegetables, legumes, rice

* Compiled from BEUCHAT (1983, 1987), CAMPBELL-PLATT (1987), HESSELTINE (1979), HESSELTINE and WANG (1980, 1986), REDDY et al. (1986) and STANTON and WALLBRIDGE (1969)