Philippine Fermented Foods
Dedicated to my husband,
Fernando (“Nanding”), and
children, Fernando Jr. (“Dindo”)
and Maria Matilde (“Nene”), as well
as to Ronald and Patricia Ann, and,
most of all, to my loving grandson,
Tristan Fernando, for their love,
encouragement, moral support,
and understanding.
Table of Contents

List of Figures xvi
List of Tables xviii
Preface xx

Section 1. Principles in Food Fermentation

Chapter I. Food Preservation by Fermentation
Definition and Importance of Fermentation 1
Role of Fermented Foods in the Food Supply 2
Nutritional Significance of Fermented Foods 5
Types of Fermentation 8
Diversity of Microbes in Fermented Foods 9

Chapter II. Microbial Functions in Fermentation Industries
Introduction 11
Historical Background of the Developments in Fermentation Industries 12
Fermentation Substrates and Materials for Process Control 14
Microbial Growth and Metabolism 18
Starter Culture Development 22
Properties of Starter Cultures 23
Microbial Culture Preservation and Management 24
Quality Control of Microbial Cultures 31
Mold Starter Culture 33
Yeast Starter Culture 34
Lactic Acid Bacterial Starter Culture 37
Acetic Acid Bacterial Culture 39
Modification of Starter Culture Properties 40
The Roles of Microorganisms in the Fermentation Processes 41
Biomass Production 41
### Section 2. Safety and Quality Aspects of Fermented Foods

#### Introduction

| Chapter III. Food Safety: Risks and Hazards in Fermented Foods | 55 |
| Biological Hazards | 55 |
| Chemical and Physical Hazards | 61 |
| Food Safety Assessments of Genetically Modified Foods | 62 |

| Chapter IV. Food Safety Management System in Fermented Foods | 65 |
| Hazard Analysis and Critical Control Points System in Food Safety | 66 |
| The HACCP Prerequisite Programs | 68 |
| HACCP Principles | 69 |
| Development of the HACCP Plan | 72 |
| Applications of the HACCP System to Fermented Food Products | 73 |
| New Strategies for Food Safety Assurance | 73 |

| Chapter V. Quality Standards for Food Products | 75 |
| Establishment of Food Standards | 76 |
| Code of Practice in Manufacturing, Processing and Holding Human Food | 77 |

### Section 3. Alcoholic Beverages

| Introduction | 89 |
| Substrates for Alcoholic Fermentation | 89 |
| Factors Affecting Alcoholic Fermentation | 90 |
| Microbial Interactions in Alcoholic Beverages | 92 |
Chapter VI. Rice Wine (Tapuy)  
Description of the Product  
Historical Background  
Traditional Processes of Tapuy Manufacture  
Microbiological Aspects of Tapuy Fermentation  
Chemical Composition of Tapuy  
Fermentation Efficiency of Traditional Bubod  
Improvement of Tapuy Production  
Optimization of the Fermentation Process  
Improvement of Bubod  
Correlation of Amylose Content of Rice with Tapuy Fermentation and Quality  
HACCP Plan for Tapuy Manufacture  

Chapter VII. Sugarcane Wine (Basi)  
Description of the Product  
Historical Background  
Chemical Composition of Basi and Additives  
Microbial Aspects of Basi Fermentation  
Microbial Population of Starters and Additives  
Microbial Changes during Basi Fermentation  
The Basi Industry  
Improved Method of Basi Production  
HACCP Plan for Basi Manufacture  

Chapter VIII. Palm Wine (Tuba) and Distilled Palm Wine (Lambanog)  
Description of the Products  
Historical Background  
Coconut Tuba Production  
Composition of Coconut Sap  
Microbial Aspects of Tuba Fermentation  
Biochemical Aspects of Tuba Fermentation  
Fermentation Control Mechanisms  
Manufacture of Lambanog
The *Lambanog* Industry
HACCP Plan for Coconut Tuba and *Lambanog* Production

*Chapter IX. Wines from Tropical Fruits*

Description of the Products
Historical Background
Tropical Fruits Suitable for Winemaking
Composition of Musts and Its Effect on Wine Quality
HACCP Plan and Process Critical Control Points in Winemaking
Quality Assessments in Wines
Sensory Attributes Evaluation

*Section 4. Lactic-Acid-Fermented Food Products*

Introduction
Important Bacteria in Lactic Acid Fermentation
Metabolic Activities of Lactic Acid Bacteria

*Chapter X. Lactic-Acid-Fermented Vegetable and Fruit Products*

Microbial Interactions in Lactic-Acid-Fermented Vegetables and Fruits

A. Cucumber Pickles Production
   Description of the Product
   Production of Salt-Stock Cucumber
   Microbiological and Biochemical Aspects of Cucumber Fermentation
   HACCP Plan and Quality Control Practices in Cucumber Pickles Manufacture

B. Fermented Mustard Leaves (*Burong Mustasa*)
   Description of the Product
   Method of Preparation

C. Pickled Pechay Leaves
   Description of the Product and Method of Manufacture

D. Pickled Green Mango (*Burong Mangga*)
   Description of the Product
   Method of Preparation
# Table of Contents

**Chapter XI. White Soft Cheese (Kesong Puti)**  
Introduction 236

- Description of the Product 237
- Microbial Interaction in *Kesong Puti* Fermentation 238
- Methods of *Kesong Puti* Manufacture 239
- Factors Affecting *Kesong Puti* Quality 243
- Microbiological and Biochemical Changes in Traditional *Kesong Puti* Manufacture 248
- HACCP Plan for *Kesong Puti* Manufacture 250
- Advances in Cheese Manufacture 252

**Chapter XII. Lactic-Acid-Fermented Fish and Fishery Products** 254

Introduction 254

A. Fermented Rice-Shrimp Mixture (*Balao-Balao*) 255

- Description of the Product 255
- Sources of Microorganisms in *Balao-Balao* 256
- Preparation of *Balao-Balao* 257
- Microbial Aspects of *Balao-Balao* Fermentation 257
- Chemical Aspects of *Balao-Balao* Fermentation 258

B. Fermented Rice-Fish Mixture (*Burong Isda*) 262

- Description of the Product 262
- Preparation of *Burong Isda* 264
- Microbial Aspects of *Burong Isda* 266
- Chemical Aspects of *Burong Isda* Fermentation 267
- Controlled *Burong Bangus* Fermentation Process 267
- Microbial Interactions in *Balao-Balao* and *Burong Isda* Fermentation 269

C. Fermented Fish (*Tinabal*) 270

- Description of the Product 270
- Preparation of *Tinabal* 271
- Different Methods of *Tinabal* Preparation 272
- Microbial Changes during *Tinabal Molmol* Fermentation 274
- Chemical Changes in the Natural Fermentation of *Tinabal Molmol* 275
- Nutritional Aspects of *Tinabal Molmol* 276
Chapter XIII. Lactic-Acid-Fermented Meat Products

Introduction

A. Fermented Native Sausage (Longanisa)
   Description of the Product
   Preparation of Longanisa
   Microbial and Chemical Aspects of Longanisa Manufacture
   HACCP Plan for Fermented Sausage (Longanisa)

B. Philippine Sweet Bacon (Tocino)
   Description of the Product
   Manufacture of Philippine Sweet Bacon (Tocino)
   HACCP Plan for Philippine Sweet Bacon (Tocino)

C. Preparation of Agos-os
   Microbial and Chemical Aspects of Agos-os Fermentation

Philippine Standard Specification for Tocino

Chapter XIV. Lactic-Acid-Fermented Coconut, Rice and Cassava Products

Introduction

A. Coconut-Based Fermented Food Products
   Description of the Product
   Pretreatments of Raw Materials
   Manufacture of White Soft Coconut Cheese
   Processing of Coconut Milk into Yoghurt
   Processing of Coconut Skim Milk into Nutri-Beverage
   Manufacture of Coco Nutri-Beverage
### B. Rice/Soybean/Cassava-Based Fermented Products

- Rice-Soy Yoghurt Manufacture
- Rice-Soy Fermented Beverage
- Cultured Rice Milk Manufacture
- Cultured Cassava Milk Manufacture
- HACCP Plans for Coconut-Based Fermented Food Products

### Section 5. Acetic-Acid-Fermented Products

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>323</td>
</tr>
<tr>
<td>Chapter XV. Fermented Vinegar</td>
<td>324</td>
</tr>
<tr>
<td>Description of the Product</td>
<td>324</td>
</tr>
<tr>
<td>Historical Background</td>
<td>325</td>
</tr>
<tr>
<td>Types of Traditional Fermented Vinegar</td>
<td>326</td>
</tr>
<tr>
<td>Microbial Aspects of Traditional Vinegar Fermentation</td>
<td>328</td>
</tr>
<tr>
<td>Mechanism of Vinegar Fermentation</td>
<td>329</td>
</tr>
<tr>
<td>Production Aspects of Vinegar Fermentation</td>
<td>330</td>
</tr>
<tr>
<td>Manufacture of Vinegar</td>
<td>332</td>
</tr>
<tr>
<td>Coconut Water Vinegar Manufacture</td>
<td>333</td>
</tr>
<tr>
<td>HACCP Plan for Vinegar Manufacture</td>
<td>335</td>
</tr>
<tr>
<td>Regulation Prescribing the Standard of Identity and Quality of Vinegar</td>
<td>336</td>
</tr>
<tr>
<td>Standard for Vinegar, Vinegar Products, and Artificial Vinegar</td>
<td>337</td>
</tr>
<tr>
<td>Chapter XVI. Nata, a Cellulosic Product</td>
<td>341</td>
</tr>
<tr>
<td>Description of the Product</td>
<td>341</td>
</tr>
<tr>
<td>Historical Background of the Industry</td>
<td>342</td>
</tr>
<tr>
<td>Characterization and Properties of Nata</td>
<td>343</td>
</tr>
<tr>
<td>The Nata Organism</td>
<td>344</td>
</tr>
<tr>
<td>Mechanism of Cellulose Synthesis</td>
<td>348</td>
</tr>
<tr>
<td>Requirements for Growth and Cellulose Production</td>
<td>352</td>
</tr>
<tr>
<td>Genetic Approach in Cellulose Synthesis</td>
<td>355</td>
</tr>
<tr>
<td>Production Aspects for Nata</td>
<td>356</td>
</tr>
</tbody>
</table>
Section 6. Fermented Foods Produced by Mixed Flora

Introduction 391
Role of Microorganisms in Mixed Fermentation 392

Chapter XVII. Fermented Rice Cake (Puto) 394
Description of the Product 394
Traditional Process for Puto Manufacture 396
Improved Method of Puto Preparation 398
Comparison of the Traditional and Improved Methods of Puto Manufacture 401
Microbiological and Biochemical Aspects of Traditional Puto Fermentation 402
Influence of Rice Variety on Puto Quality 403
HACCP Plan for Fermented Puto Manufacture 404

Chapter XVIII. Fish Paste (Bagoong) and Fish Sauce (Patis) 405
Introduction 405
Description of the Product 407
Microbial Interactions in Bagoong and Patis Fermentation 409
Traditional Process of Bagoong and Patis Manufacture 409
Microbial Aspects of the Traditional Method of Bagoong and Patis Manufacture 413
Biochemical Aspects of Bagoong and Patis Manufacture 414
Acceleration of Fish Sauce Manufacture 418
The Bagoong and Patis Industry 421
HACCP Plan for Bagoong and Patis Manufacture 423
Table of Contents

Philippine Standard for Bagoong (Fish Paste)  
PHILSA II-2-63  424
Philippine National Standard for Fish Sauce (*Patîs*) PNS 413:1993  429
Thai Standard for Fish Sauce (TIS 3-25 26:1983)  435

Chapter XIX. *Soy Sauce and Soy Sauce-Like Products*  440
Description of the Products  440
Soy Sauce Manufacture in the Philippines  442
  Traditional Method of Soy Sauce Manufacture  443
  Chemical Hydrolysis Method of Soy Sauce Manufacture  444
The Philippine Soy Sauce Industry  445
Advances in Soy Sauce Manufacture  447
Mungbean Sauce Technology  451
HACCP Plan for Soy Sauce Manufacture  453
Philippine Standards for Soy Sauce (PNS 274:1993)  454

References  465
Index  511
List of Figures

1. Diagrammatic representation of normal bacterial growth curve / 19
2. Newly prepared *bubod/binokbok* using Benguet (A) and Ifugao (B) methods / 102
3. Roasting or cooking of milled rice grains for the preparation of *tapuy* / 104
4. Cooling of cooked rice and addition of *bubod* in tray made of rattan / 104
5. Bottled *tapuy* sold commercially / 105
6. Flow diagram of Ifugao method of rice wine preparation / 122
7. Microbial changes in the traditional La Union method of basi fermentation / 132
8. Bacterial flora changes in the La Union method of basi fermentation / 134
9. Traditional method of sugarcane juice extraction / 137
10. Flow diagram of the La Union method of basi preparation / 139
11. Newly extracted sugarcane juice / 140
12. Pouring of newly extracted sugarcane juice into the iron kettle / 140
13. Boiling of sugarcane juice provided with bamboo basket with open ends to prevent overflow / 141
14. Checking the concentration of sugarcane juice with bamboo stick / 142
15. La Union method of basi fermentation / 143
16. Aging stage of sugarcane wine inside the nipa hut / 143
17. Flow diagram of the Ilocos method of basi preparation / 144
18. Flow diagram of the Pangasinan method of basi preparation / 146
19. Flow diagram for the preparation of improved *bubod* for basi preparation / 148
20. Flow diagram of the improved method of basi preparation / 149
21. Tuba gatherer on top of the coconut frond collecting sap / 156
22. Receptacle, locally termed *kawit*, used as container for sap collection / 157
List of Figures

23 Spontaneous fermentation of coconut sap for lambanog / 159
24 Distillation setup for lambanog manufacture / 169
25 Different tropical fruit wines from various fruits / 175
26 Different size classifications of cucumber for pickling / 224
27 Fully (A) and half-fermented (B) cucumber pickles / 230
28 Pouring and packaging of kesong puti (Laguna method) / 240
29 Burong tilapia fermentation / 265
30 Flow diagram of the traditional processing of tinabal molmol / 273
31 Flow sheet in the traditional processing of tinabal mongko / 274
32 Flow diagram of processing white soft coconut cheese / 306
33 Flow diagram of the procedure for the manufacture of coco-yoghurt / 311
34 Flow diagram for processing coco nutri-beverage / 315
35 Natural fermentation of coconut/nipa sap in earthen jars / 332
36 Zoogleal mat formed by acetic acid bacteria during fermentation of coconut water / 334
37 Scanning electron micrograph of cellulose fibrils with entrapped cells of Acetobacter xylinum / 350
38 Scanning electron micrograph of nata de piña (10,000 X) / 357
39 Scanning electron micrograph of nata de coco produced in coconut medium (10,000 X) / 360
40 Fermentation system for nata de coco commercial production / 362
41 Flow diagram of standard method of puto preparation / 396
42 Flow diagram of shortened method of puto preparation using ground milled rice / 400
43 Flow diagram of shortened puto preparation using rice flour / 400
## List of Tables

1. Groups of fermented foods worldwide / 3
2. Philippine fermented foods classified according to the type of microorganisms involved in fermentation / 10
3. Traditional starter cultures used in Asian fermented foods / 23
4. Sources of microbial enzymes and diversity of commercial application in the food industry / 43
5. Maximum tolerable levels of aflatoxins in food stuffs in Asian countries / 57
6. Occurrence of toxicogenic fungi in traditional fermented foods / 59
7. Rice wine and starter cultures employed in different countries / 97
8. Microbial load of *bubod* samples collected from various places / 98
9. Yield, alcohol content, and fermentation efficiency of the different *bubod* in rice wine preparations / 107
10. *Tapuy* processing characteristics of milled rice grains of varying amylose content and their correlation with starch properties and protein content / 110
11. Mean scores by eight panelists of one-month-old *tapuy* from 10 varieties of milled rice / 113
12. Average chemical composition of sweet-type (*basing babae*) and bitter-type (*basing lalakt*) sugarcane wine from different production areas / 127
13. Microbial flora of basi fermentation using three methods of preparation / 133
14. Physical and chemical characteristics of coconut sap from different sources / 160
15. Amino acid (mg/100 g) and vitamin contents of freshly gathered coconut sap and tuba / 161
16. Microbiological and chemical changes in fresh tuba and tuba with added tanbark / 162
17. Yeast flora of coconut tuba from different production areas / 163
18. Microflora population in palm sap when 10 g of bark was added to 100 mL of palm sap / 164
19. Philippine fruits suitable for wine manufacture and their seasons of production / 177
List of Tables

20A Chemical composition of Philippine fruits suitable for wine manufacture / 178
20B Composition of Philippine fruits suitable for wine manufacture / 179
20C Composition of Philippine fruits suitable for wine manufacture / 180
21 Temperature correction factor for determination of specific gravity / 183
22 Conversion table for specific gravity, gravity, sugar present, and potential alcohol percentage by volume / 183
23 Corresponding acidities in parts per thousand of various acids / 188
24 Recommended parameters for the production of tropical wines / 193
25 Acid-fermented vegetable and fruit products and corresponding essential lactic acid bacteria / 215
26 Acid-fermented milk products and corresponding essential lactic acid bacteria / 216
27 Acid-fermented milk and cereal products and corresponding essential lactic acid bacteria / 216
28 Acid-fermented meat, fish, and fishery products and corresponding essential microorganisms / 216
29 Composition of fresh and fermented mustard leaves per 100 g edible portion / 232
30 Penetrometer readings (mm) on mango slices of the “piko” and “carabao” varieties at two stages of maturity during brining / 235
31 Composition of raw carabao and cow milks and kesong puti per 100 g edible portion / 238
32 Average composition of the different kinds of milk / 244
33 Average cheese yield of different types of milk using the three methods of soft cheese manufacture / 245
34 Current nomenclature of lactic starters / 247
35 Plasmid-mediated properties of thermophilic lactic starters / 248
36 Plasmid-mediated properties of lactic Streptococci / 249
37 Chemical composition (per 100 g edible portion) of the different types of shrimps used for the preparation of balao-balao / 255
38 Average amino acid composition (g/16 g N) and chemical score (%) of four-day balao-balao / 261
39 Chemical composition (per 100 g edible portion) of the different fish used in the preparation of burong isda / 263
Types or kinds of *burong isda* produced in the Philippines / 263

Changes in pH and titratable acidity (%) in inoculated *burong bangus* / 268

Chemical composition of fish (per 100 g edible portion) used for the preparation of *tinabal* / 271

Microbial changes in naturally fermenting *burong talangka* / 279

Chemical changes in naturally fermenting *burong talangka* / 280

Chemical composition of different types of sausages per 100 g edible portion / 284

Chemical composition of different types of *tocino* (sweet-cured meat) per 100 g edible portion / 292

Composition of coconut milk (CM), nonfat dry milk (NFDM), cow milk, and carabao milk per 100 g edible portion / 304

Chemical analysis and yield of white soft cheese made from various combination of coconut milk and skim milk / 307

Average composition of three types of white soft cheese / 308

Average values of coconut milk and coconut skim milk per nut and their chemical composition / 313

Chemical composition of vinegars from coconut sap, nipa sap, and pineapple juice per 100 g edible portion / 327

Chemical composition (per 100 g edible portion) of different types of rice cakes / 395

Microbiological and chemical changes in the traditional *puto* fermentation / 402

Fish paste and fish sauce products in different countries / 405

Chemical composition (per 100 g edible portion) of bagoong and *patis* / 407

Amino acid content (mg/100 mL) at various stages of *patis* made from *dilis* (*Stolephorus sp.* ) and mixed fish species / 416

Chemical analysis of fish sauce produced by accelerated and traditional process / 419

Chemical composition (per 100 g edible portion) of Philippine fermented soybean sauce and pastes / 441

Chemical composition (per 100 g edible portion) of mungbean and soybean / 451

Mean chemical composition of sauce obtained from mungbean compared to soy sauce / 452