

Contents

Third Edition Preface.....	ix
Chapter 1	
Raw Materials	1
1.1 Introduction	1
1.2 Sources of Fats and Oils.....	2
1.3 Vegetable Oil Yields	2
1.4 Availability of Fats and Oils	4
1.5 United States Utilization of Edible Fats and Oils	4
1.6 Characterization of Fats and Oils	7
1.7 Nonglyceride Components of Fats and Oils.....	8
1.7.1 Phospholipids	8
1.7.2 Tocopherols and Tocotrienols	9
1.7.3 Sequalene	10
1.7.4 Sterols	10
1.7.5 Pigments.....	12
1.7.6 Pesticides.....	13
1.7.7 Trace Metals.....	13
1.8 Genetically Modified Vegetable Oils.....	13
1.9 Soybean Oil.....	15
1.9.1 Soybean Oil Composition and Physical Properties	17
1.9.2 Genetically Modified Soybean Oil	18
1.10 Cottonseed Oil	19
1.10.1 Cottonseed Oil Composition and Physical Properties	20
1.10.2 Genetically Modified Cottonseed Oil.....	22
1.11 Peanut Oil.....	22
1.11.1 Peanut Oil Composition and Physical Properties	23
1.11.2 Genetically Modified Peanut Oil	25
1.12 Corn Oil	25
1.12.1 Corn Oil Composition and Physical Properties	26
1.12.2 Genetically Modified Corn Oil.....	28
1.13 Sunflower Oil	28
1.13.1 Sunflower Oil Composition and Physical Properties	29
1.14 NuSun Sunflower Oil	30
1.14.1 NuSun Composition and Physical Properties	31
1.15 High-Oleic Sunflower Oil	32
1.15.1 High-Oleic Sunflower Oil Physical Properties and Composition	32
1.16 Safflower Oil	33
1.16.1 Safflower Oil Composition and Physical Properties.....	33

1.17	High-Oleic Safflower Oil	35
1.17.1	High-Oleic Safflower Oil Composition and Physical Characteristics	35
1.18	Canola Oil	37
1.18.1	Canola Oil Composition and Physical Properties.....	37
1.18.2	Genetically Modified Canola Oil.....	39
1.19	Olive Oil.....	40
1.19.1	Olive Oil Composition and Physical Properties	41
1.20	Palm Oil	43
1.20.1	Palm Oil Composition and Physical Properties.....	43
1.20.2	Genetically Modified Palm Oil.....	47
1.21	Coconut Oil	48
1.21.1	Coconut Oil Composition and Physical Properties.....	48
1.22	Palm Kernel Oil	50
1.22.1	Palm Kernel Oil Composition and Physical Properties.....	51
1.23	Lard	52
1.23.1	Lard Physical Properties and Composition.....	53
1.24	Tallow.....	55
1.24.1	Tallow Physical Properties and Composition	56
1.25	Milk Fat.....	58
1.25.1	Milk Fat Physical Properties and Composition	58
1.26	Menhaden Oil.....	60
1.27	Single Cell Oils	64
1.27.1	Microalgae Oils	64
1.27.2	Fungal Oil	65
	References	66

Chapter 2

	Fats and Oils Processing	73
2.1	Introduction.....	73
2.2	Fats and Oils Recovery	74
2.2.1	Oilseed Extraction	74
2.2.1.1	Expeller or Screw Press Extraction.....	76
2.2.1.2	Prepress Solvent Extraction.....	77
2.2.1.3	Direct Solvent Extraction	77
2.2.2	Oil-Bearing Fruit Extraction.....	78
2.2.2.1	Olive Oil Extraction	78
2.2.2.2	Palm Oil Extraction.....	78
2.2.3	Animal Fat Recovery	79
2.2.3.1	Wet Rendering.....	79
2.2.3.2	Dry Rendering.....	79
2.3	Refining Systems.....	80
2.4	Physical Refining	80

2.5	Refining Pretreatment	83
2.5.1	Water Degumming.....	84
2.5.2	Acid Degumming.....	85
2.5.3	Dry Degumming.....	86
2.5.4	Enzymatic Degumming	86
2.5.5	Modified Acid Degumming.....	87
2.5.6	Membrane Filter Degumming	87
2.6	Chemical Refining	88
2.6.1	Short-Mix Caustic Refining.....	92
2.6.2	Miscella Refining.....	92
2.6.3	Batch Caustic Refining	95
2.6.3.1	Dry-Method Batch Refining.....	95
2.6.3.2	Wet-Method Batch Refining.....	96
2.6.4	Silica Refining.....	96
2.6.5	Refining Efficiency	97
2.6.6	Refining Byproducts	98
2.6.6.1	Soapstock Processing	98
2.6.6.2	Hydrated Gums Processing	100
2.7	Prebleaching	100
2.7.1	Procedure	101
2.7.1.1	Batch Atmospheric	101
2.7.1.2	Batch Vacuum	101
2.7.1.3	Continuous Vacuum	101
2.7.2	Bleaching Agents	103
2.7.2.1	Natural Bleaching Earth.....	103
2.7.2.2	Activated Bleaching Earth	103
2.7.2.3	Reuse Spent Bleaching Earth.....	104
2.7.2.4	Activated Carbon.....	104
2.7.2.5	Silica Adsorbent	105
2.7.3	Bleaching Earth Dosage	105
2.7.4	Temperature	106
2.7.5	Time	107
2.7.6	Moisture	107
2.7.7	Filtration.....	108
2.7.8	Bleaching Byproduct.....	109
2.8	Hydrogenation	110
2.8.1	Operating Variables	113
2.8.1.1	Temperature.....	113
2.8.1.2	Pressure	113
2.8.1.3	Agitation.....	114
2.8.1.4	Catalyst Level.....	114
2.8.1.5	Catalyst Type	114
2.8.1.6	Catalyst Poisons.....	115

2.8.1.7	Catalyst Reuse	116
2.8.1.8	Source Oils	116
2.8.2	Hydrogenation Systems.....	116
2.8.3	Hydrogenation Control.....	118
2.8.4	Hydrogenated Basestock System	119
2.9	Interestesterification	122
2.9.1	Chemical Rearrangement Catalyst	124
2.9.2	Endpoint Control.....	126
2.9.2.1	Melting Point	126
2.9.2.2	Fiber Optic Spectrometer Monitoring.....	126
2.9.2.3	Solids Fat Index	127
2.9.2.4	Differential Scanning Calorimetry	127
2.9.2.5	Glyceride Compositional Analysis	128
2.9.3	Random Chemical Interestesterification Processes	128
2.9.4	Directed Chemical Interestesterification Process	130
2.9.5	Enzymatic Interestesterification.....	131
2.9.6	Interesterified Fats and Oils Applications	132
2.10	Winterization.....	133
2.10.1	Classical Winterization Process.....	133
2.10.2	Winterization Principle.....	134
2.10.2.1	Source Oil Composition	135
2.10.2.2	Cooling Rate.....	135
2.10.2.3	Crystallization Temperature.....	135
2.10.2.4	Agitation Rate	135
2.10.2.5	Crystallization Time.....	136
2.10.3	Solvent Winterization	136
2.10.4	Winterization Process Control Procedures.....	137
2.10.5	Winterization Applications	138
2.11	Dewaxing	139
2.11.1	Dewaxing Process Control	140
2.11.2	Dewaxing Applications.....	140
2.12	Fractionation	140
2.12.1	Dry Crystal Fractionation	142
2.12.2	Detergent Fractionation.....	142
2.12.3	Solvent Fractionation	143
2.13	Postbleaching	144
2.14	Cholesterol Stripping Process	145
2.15	Esterification or Alcoholsysis	146
2.15.1	Mono- and Diglycerides	146
2.15.1.1	Monoglyceride Derivatives	148
2.15.2	Polyglycerol Ester	150
2.15.3	Propylene Glycol Monoester.....	152
2.16	Blending	152
2.17	Deodorization.....	153
2.17.1	Operating Variables	154

2.17.1.1	Vacuum.....	154
2.17.1.2	Temperature.....	154
2.17.1.3	Stripping Steam.....	155
2.17.1.4	Retention Time	156
2.17.2	Deodorization Systems	156
2.17.2.1	Batch.....	156
2.17.2.2	Semicontinuous Deodorization.....	157
2.17.2.3	Continuous Deodorization	158
2.17.3	Deodorizer Heating Systems	159
2.17.4	Deodorization Process Control.....	160
2.17.5	Deodorizer Distillated	161
2.18	Finished Fats and Oils Handling.....	164
2.18.1	Protection against Oxidative Deterioration	164
2.18.1.1	Nitrogen Blanketing	164
2.18.1.2	Temperature Control	165
2.18.1.3	Light Control	166
2.18.1.4	Storage Time	166
2.18.1.5	Antioxidant Addition.....	166
2.18.1.6	Synergistic Antioxidant Mixtures	168
2.18.2	Protection against Contamination.....	169
2.19	Plasticization	170
2.19.1	Plasticity of Edible Fats and Oils.....	170
2.19.1.1	Product Composition.....	170
2.19.1.2	Crystal Size	171
2.19.1.3	Supercooling.....	171
2.19.1.4	Mechanical Working	172
2.19.1.5	Gas Incorporation.....	172
2.19.2	Solidification Apparatus Evolutions	172
2.19.3	Shortening Plasticization Process.....	174
2.19.4	Liquid Shortening Crystallization	176
2.19.5	Margarine Plasticization Process.....	177
2.19.5.1	Stick Margarine.....	180
2.19.5.2	Soft-Tub Margarine	180
2.19.5.3	Whipped-Tub Margarine	181
2.19.5.4	Liquid Margarine	181
2.19.5.5	Industrial Margarines.....	182
2.19.6	Tempering	182
2.19.6.1	Quick Tempering.....	183
2.20	Flaking	185
2.20.1	Chill Rolls	186
2.20.2	Flake Crystallization.....	186
2.20.3	Flaking Conditions	186
2.21	Powdered and Beaded Fats	187
2.21.1	Spray Cooling	188

2.21.2	Flake Grinding	188
2.21.3	Spray Flaking and Grinding	188
2.22	Salad and Cooking Oils Packaging.....	189
2.23	Bulk Oil Shipments	189
2.23.1	Contamination.....	190
2.23.2	Overheating.....	190
2.23.3	Air Exposure.....	190
	References	191

Chapter 3

	Fats and Oils Analysis	197
3.1	Introduction.....	197
3.2	Nonfatty Impurities.....	198
3.2.1	Moisture Analysis.....	198
3.2.1.1	Hot Plate Method	198
3.2.1.2	Air Oven Method	199
3.2.1.3	Vacuum Oven Method.....	199
3.2.1.4	Karl Fisher Method	199
3.2.1.5	Skillet Moisture	199
3.2.2	Impurities Analysis	200
3.2.2.1	Insoluble Impurities.....	200
3.2.2.2	Filterable Impurities (Standard Disk Method)	200
3.2.2.3	Turbidimeter Impurities	200
3.2.3	Trace Metals Analysis.....	201
3.2.4	Soap Analysis.....	201
3.3	Melting, Solidification, and Consistency	201
3.3.1	Melting Point Analysis.....	202
3.3.1.1	Capillary Melting Point	202
3.3.1.2	Softening Point	202
3.3.1.3	Slipping Point	202
3.3.1.4	Wiley Melting Point	203
3.3.1.5	Mettler Dropping Point	203
3.3.2	Solid–Liquid Relationships.....	203
3.3.2.1	Solids Fat Index	204
3.3.2.2	Solids Fat Content	204
3.3.2.3	Differential Scanning Calorimetry Fat Solids Content	206
3.3.3	Solidification Analysis	207
3.3.3.1	Titer	207
3.3.3.2	Quick Titer	207
3.3.3.3	Congeal Point	207
3.3.3.4	Cloud Point.....	208
3.3.3.5	Cold Test.....	208
3.3.3.6	Chill Test	208

3.3.4	Consistency Analysis	208
3.3.4.1	Consistency Ratings	209
3.3.4.2	Penetrations	209
3.4	Composition Analysis	210
3.4.1	Saponification Value	211
3.4.2	Iodine Value	211
3.4.3	Refractive Index	212
3.4.4	Fatty Acid Composition	213
3.4.5	Calculated Iodine Value.....	214
3.4.6	Glyceride Structure	215
3.4.7	Emulsifier Analysis.....	215
3.4.8	Antioxidant Analysis	216
3.4.9	Tocopherol Analysis	216
3.5	Flavor, Rancidity, and Stability.....	217
3.5.1	Flavor Analysis	217
3.5.1.1	Sensory Evaluations	218
3.5.1.2	Volatile Flavor Analysis	219
3.5.2	Rancidity Analysis	219
3.5.2.1	Peroxide Value.....	219
3.5.2.2	Anisidine Value	220
3.5.2.3	Free Fatty Acid and Acid Value	220
3.5.2.4	Smoke Point.....	221
3.5.3	Stability Analysis.....	221
3.5.3.1	Active Oxygen Method.....	222
3.5.3.2	Oil Stability Index	223
3.5.3.3	Schaal Oven Test	223
3.5.3.4	Pastry Flavor Test.....	224
3.6	Color and Appearance.....	224
3.6.1	Color.....	225
3.6.1.1	Wesson Color Method	225
3.6.1.2	Lovibond (British Standard)	225
3.6.1.3	Spectrophotometric Color Method for Oils	226
3.6.1.4	Automatic Tintometers.....	226
3.6.1.5	FAC (Fatty Acid Committee) Method.....	226
3.6.1.6	Gardner Color.....	227
3.6.1.7	Chlorophyll.....	227
3.6.1.8	Coloring Agents Determination	227
3.6.2	Appearance	227
3.6.2.1	Product Appearance Ratings.....	227
3.7	Refining and Bleaching	228
3.7.1	Refining Loss	228
3.7.2	Neutral Oil and Loss	229
3.7.3	Bleaching Analysis	229
3.8	Performance Testing	229
3.8.1	Creaming Volume	230

3.8.2	Pound Cake Test	231
3.8.3	Icing Volume.....	231
3.8.4	White Layer Cakes.....	232
3.8.5	Crème Filling Test.....	232
3.8.6	Cake Mix Evaluation	233
3.8.7	Puff Pastry Testing.....	233
3.8.8	Restaurant Deep-Fat Frying Evaluation	233
3.8.9	Ice Cream Bar Coating Evaluation	234
3.9	Nonstandardized Methods	234
	References	260

Chapter 4

	Fats and Oils Formulation.....	263
4.1	Introduction	263
4.2	Oils and Fats Characteristics	265
4.2.1	Saturated Fatty Acids.....	265
4.2.1.1	Short-Chain Fatty Acids.....	267
4.2.1.2	Medium-Chain Fatty Acids.....	267
4.2.1.3	Long-Chain Fatty Acids	268
4.2.2	Unsaturated Fatty Acids.....	269
4.2.2.1	Monounsaturated Fatty Acids	269
4.2.2.2	Polyunsaturated Fatty Acids	270
4.2.3	Isomerized Fatty Acids	273
4.2.3.1	Positional Isomers	273
4.2.3.2	<i>Trans</i> Fatty Acids	273
4.2.3.3	Conjugated Linoleic Fatty Acid (CLA)	274
4.3	Palatability	275
4.3.1	Oxidation	276
4.3.1.1	Flavor Reversion.....	280
4.3.1.2	Antioxidants	281
4.3.2	Hydrolysis	283
4.3.3	Mouth Feel	283
4.4	Physical Characteristics	285
4.4.1	Fat Crystal Habit	285
4.4.2	Fat Plasticity.....	288
4.4.3	Solid–Liquid Relationships.....	289
4.4.3.1	Hydrogenation	289
4.4.3.2	Random Interesterification	291
4.4.3.3	Directed Interesterification.....	295
4.4.3.4	Fractionation.....	295
4.5	Nutritional Considerations	297
4.5.1	Nutritional Facts Panel.....	298
4.5.2	Health Claims	299
4.5.3	2005 Dietary Guidelines for Americans.....	300

4.5.4	Package Ingredient Statement.....	300
4.6	Basestock System.....	301
4.7	Solids–Liquids Characteristics	302
4.7.1	Wide Plastic-Range Fats and Oils Products	305
4.7.2	Steep Solid Fat Index Slopes.....	308
4.7.3	Liquid Opaque or Pumpable Products.....	311
4.8	Emulsification	312
4.8.1	Mono- and Diglycerides	314
4.8.2	Propylene Glycol Esters	316
4.8.3	Sorbitan Esters	317
4.8.4	Polysorbate Fatty Acid Esters	317
4.8.5	Polyglycerol Esters.....	318
4.8.6	Lactated Esters.....	318
4.8.7	Lecithin.....	319
4.8.8	Emulsifier Selection Methods.....	320
4.8.8.1	Hydrophilic/Lipophilic Balance System.....	320
4.8.8.2	Emulsifier Functionality Traits.....	323
4.8.8.3	Emulsifier Selection Procedure	324
4.9	Product Development	325
4.9.1	Application Product Development.....	325
4.9.2	Analytical Development	327
4.9.2.1	Solids Fat Index Calculations.....	327
4.9.3	Triglyceride Replication.....	328
4.10	Source Oils and Fats Interchangeability	333
4.11	Reduced <i>Trans</i> Fatty Acid Formulation.....	334
4.12	Essential Fatty Acid Fortification	337
4.12.1	Essential Fatty Acid Sources	337
4.12.2	Omega-3 Fortified Products.....	338
	References	339

Chapter 5

	Shortening Types	347
5.1	Introduction	347
5.1.1	Historical Background	347
5.1.2	Source Oils.....	351
5.1.3	Shortening Product Forms	355
5.2	Plasticized Shortening Applications	355
5.3	Liquid Shortening Applications	357
5.4	Flakes, Chips, and Powdered Shortening Applications	358
	References	359

Chapter 6

	Baking Shortenings.....	361
6.1	Introduction	361

6.2	All-Purpose Shortenings.....	363
6.3	Emulsified All-Purpose Shortening.....	368
6.4	Retail Cake Mix Shortenings.....	370
6.5	Specialty Bakery Cake Shortenings.....	373
6.6	Liquid Cake Shortening	374
6.7	Icing and Filling Shortenings.....	376
6.8	Icing Stabilizers	378
6.9	Bread Shortening	379
6.10	Liquid Bread Shortenings	381
6.11	Sweet Yeast-Raised Dough Shortenings.....	383
6.12	Cookie Shortenings.....	384
6.13	Cookie Filler Shortenings	384
6.14	Pie Crust Shortenings.....	386
6.15	Biscuit Shortenings	387
6.16	Danish Pastry Roll-In Shortenings	389
6.17	Puff Paste Roll-In Shortening	392
6.18	Shortening Chips.....	394
6.19	Cracker Shortenings.....	395
	References	396

Chapter 7		
	Frying Shortenings	399
7.1	Introduction.....	399
7.2	Frying Shortening Additives.....	402
7.3	Selection of Frying Shortening	404
7.3.1	Product Characteristics	405
7.3.2	Frying Life	405
7.3.3	Shelf Life.....	406
7.4	Foodservice Deep-Fat Frying Shortening Applications	407
7.4.1	Foodservice All-Purpose Shortening	409
7.4.2	Animal-Vegetable Blended Frying Shortening	410
7.4.3	Heavy-Duty Vegetable Frying Shortenings	410
7.4.4	Liquid Frying Shortenings.....	411
7.4.5	Trait-Enhanced Vegetable Oils	412
7.5	Foodservice Pan and Grill Shortenings	414
7.6	Bakery Frying Shortening Applications	416
7.6.1	Cake Donut Shortenings	417
7.6.2	Yeast-Raised Fried Products.....	419
7.6.3	Fried-Pie Shortenings	419
7.7	Snack Frying Shortening Applications	420
7.7.1	Nut Meats Oil Roasting	422
	References	422

Chapter 8

Dairy Analog Shortenings	425
8.1 Introduction.....	425
8.2 Nondairy Creamer	426
8.3 Whipped Topping.....	429
8.4 Cheese Analog	431
8.5 Frozen Dessert or Mellorine	432
8.6 Sour Cream Analog and Dip Bases	433
8.7 Fluid Milk Analogs.....	434
8.8 Sweetened Condensed Milk Analogs	434
References	436

Chapter 9

Household Shortenings	437
9.1 Introduction.....	437
9.2 Household Shortening Development.....	437
9.3 Household Shortening Product Requirements	439
9.4 Household Shortening Formulation	440
9.5 Household Shortening Plasticization	444
9.6 Household Shortening Packaging	444
References	445

Chapter 10

Margarine.....	447
10.1 Introduction.....	447
10.2 Margarine Development.....	447
10.3 Margarine Formulation	453
10.3.1 Milk Products or Protein	453
10.3.2 Emulsifiers	454
10.3.3 Flavoring Materials.....	454
10.3.4 Preservatives	455
10.3.5 Vitamins and Color.....	455
10.3.6 Supplements for Health Claims	456
10.3.7 Margarine Oils and Fats	456
10.4 Low-Fat Margarine or Spread.....	457
10.5 Consumer Margarine Oil Formulations.....	459
10.5.1 Margarine Oil Formulations with Hydrogenated Oils.....	459
10.5.2 Margarine Oil Formulation with Interesterified Oils	461
10.5.3 Margarine Oil Formulation with Fractionated Oils.....	464
10.5.4 Margarine Oil Formulation with Unmodified Oils	464

10.6	Industrial Margarine Formulations.....	465
10.7	Margarine and Spread Preparation.....	466
10.7.1	Stick Margarine or Spread.....	467
10.7.2	Soft Tub Margarine or Spread	468
10.7.3	Whipped Tub Margarine or Spread	469
10.7.4	Liquid Margarine.....	469
10.7.5	Industrial Margarines or Spreads	469
	References	470
Chapter 11		
	Liquid Oils	473
11.1	Introduction	473
11.2	Development of Liquid Oils	474
11.3	Cooking and Salad Oil Sources	476
11.4	Retail Consumer Oils.....	479
11.5	Industrial Salad Oil Applications.....	481
11.6	Mayonnaise	482
11.6.1	Mayonnaise Ingredients	483
11.6.1.1	Salad Oil.....	483
11.6.1.2	Vinegar	485
11.6.1.3	Eggs	485
11.6.1.4	Flavoring Ingredients	485
11.6.2	Mayonnaise Processing.....	486
11.7	Spoonable Salad Dressing.....	487
11.8	Pourable Salad Dressings.....	488
11.8.1	French Dressing	489
11.9	High-Stability Oils.....	490
11.9.1	Processed High-Stability Oils	490
11.9.2	Plant Breeding.....	490
11.9.3	High-Stability Oil Applications	491
	References	492
Chapter 12		
	Quality Management	495
12.1	Introduction	495
12.2	Operating Standards	496
12.3	Specifications	496
12.3.1	Specifications Format	497
12.3.2	Ingredient Specifications	499
12.3.2.1	Ingredient Specifications Format	501
12.3.3	Packaging Specifications	502
12.3.3.1	Packaging Specifications Format	503
12.3.4	Product Specifications.....	504
12.3.4.1	Product Specifications Format	505

12.3.5 Customer Instruction Specifications	506
12.3.5.1 Customer Instruction Specifications Format.....	506
12.3.6 Summary Specifications	508
12.3.6.1 Summary Specifications Format.....	508
12.4 Procedures.....	509
12.4.1 Procedures Format.....	509
12.4.2 Quality Procedures	509
12.4.2.1 Complaint Handling Procedure	510
12.4.2.2 Product Recall Procedure.....	511
12.4.2.3 Product Identification Procedures	513
12.4.2.4 Specification Change Requisition	515
12.4.2.5 New Product Approval Procedure	517
12.4.2.6 Weight Control Program	518
12.4.2.7 Quality Cost System.....	518
12.4.2.8 Label Approval Procedure	520
12.5 Methods.....	521
12.5.1 Methods Format.....	522
12.6 Process Control Overview	524
12.7 Crude Fats and Oils Process Control	526
12.8 Refining Process Control	527
12.9 Prebleaching Process Control	530
12.10 Modification Processes	532
12.10.1 Hydrogenation Process Control	533
12.10.2 Interesterification Process Control.....	535
12.10.2.1 Random Interestesterification Using Chemical Catalyst	536
12.10.2.2 Random Interestesterification Using Enzyme Catalyst	538
12.10.3 Fractionation Process Control.....	539
12.10.3.1 Winterization Process Control	540
12.10.3.2 Dewaxing Process Control	540
12.11 Postbleach Process Control	542
12.12 Blending Process Control.....	544
12.13 Deodorization Process Control	544
12.14 Bulk Shipment Process Control	546
12.15 Plasticized Shortening Packaging Process Control	547
12.16 Liquid Shortening Packaging Process Control	550
12.17 Liquid Oils Packaging Process Control	552
12.18 Shortening Flake Process Control Standards	554
12.19 Margarine and Spread Process Control Standards	556
References	559
 Chapter 13	
Troubleshooting	561
13.1 Introduction.....	561
13.2 Process Troubleshooting	563

13.2.1	Vegetable Oil Extraction.....	563
13.2.2	Meat Fat Rendering.....	566
13.2.3	Crude Oil Storage	566
13.2.4	Degumming	570
13.2.5	Caustic Oil Refining: Primary Centrifuge.....	571
13.2.6	Oil Refining: Water Wash	574
13.2.7	Oil Refining: Vacuum Drying.....	575
13.2.8	Prebleaching.....	575
13.2.9	Hydrogenation.....	578
13.2.10	Interesterification	580
13.2.11	Postbleaching	581
13.2.12	Winterization	582
13.2.13	Dewaxing	584
13.2.14	Esterification	585
13.2.15	Blending	588
13.2.16	Deodorization	589
13.2.17	Antioxidant Addition	598
13.2.18	Bulk Railroad Car or Truck Loading	600
13.2.19	Oil Filling and Packaging	603
13.2.20	Packaged Liquid Oils: Storage and Transportation	604
13.2.21	Shortening Packaging	605
13.2.22	Liquid Opaque Shortenings	611
13.2.23	Shortening Flakes	614
13.2.24	Packaged Shortening: Storage and Transportation.....	621
13.2.25	Quality Control Laboratory	622
13.2.26	Edible Fats and Oils: Organoleptic Evaluations	624
13.2.27	Edible Fats and Oils Formulation	627
13.2.28	Edible Fats and Oils: Processed Oil Storage	629
13.3	Shortening Applications.....	629
13.3.1	Baking Shortening	629
13.3.2	Frying Shortenings	633
13.4	Margarine and Spread Products.....	644
13.5	Quality Management.....	649
	References	656
	Index	659