

YEASTS, YEAST EXTRACTS, AUTOLYSATES AND RELATED PRODUCTS: THE GLOBAL MARKET



CHM053B
July 2014

Ulrich Marz
Project Analyst

ISBN: 1-56965-892-7

bcc | Research
Market Forecasting

BCC Research
49 Walnut Park, Building 2
Wellesley, MA 02481 USA
866-285-7215 (toll-free within the USA),
or (+1) 781-489-7301
www.bccresearch.com
information@bccresearch.com

TABLE OF CONTENTS

| TOPIC | PAGE NO. |
|--|----------|
| CHAPTER 1 INTRODUCTION | 2 |
| STUDY GOALS AND OBJECTIVES | 2 |
| REASONS FOR DOING THE STUDY | 3 |
| SCOPE OF REPORT | 4 |
| METHODOLOGIES | 4 |
| INFORMATION SOURCES | 4 |
| ANALYST'S CREDENTIALS | 5 |
| RELATED BCC RESEARCH REPORTS | 5 |
| BCC RESEARCH WEBSITE | 5 |
| DISCLAIMER | 5 |
| CHAPTER 2 SUMMARY | 7 |
| <i>SUMMARY TABLE GLOBAL MARKET VALUE FOR YEAST PRODUCTS, BY TYPE, THROUGH 2019 (\$ MILLIONS)</i> | 8 |
| <i>FIGURE 01 MARKET VALUE OF YEAST PRODUCTS BY REGION, 2013 (\$ MILLIONS)</i> | 8 |
| <i>FIGURE 02 RELEVANCE OF APPLICATION SECTORS FOR THE GLOBAL YEAST MARKETS, 2013 (%)</i> | 9 |
| <i>FIGURE 03 GLOBAL MARKET VALUE FOR YEAST PRODUCTS, BY TYPE, 2013 AND 2019 (\$ MILLIONS)</i> | 9 |
| CHAPTER 3 BASICS OF YEAST PRODUCTION | 12 |
| HISTORY AND ELEMENTARY CHARACTERISTICS OF YEAST | 12 |
| <i>TABLE 1 CARBOHYDRATE SOURCE ALTERNATIVES TO MOLASSES BY TYPE OF YEAST</i> | 12 |
| TERMINOLOGY | 13 |
| MANUFACTURING OF YEAST | 15 |
| OVERVIEW AND PRINCIPLES | 15 |
| <i>FIGURE 1 FLOW CHART FOR THE PRODUCTION OF YEAST BIOMASS</i> | 16 |
| <i>TABLE 2 `PROPERTIES OF COMMERCIAL YEAST FORMS</i> | 16 |
| EQUIPMENT FOR AND DIMENSIONING OF YEAST PRODUCTION FACILITIES | 17 |
| <i>TABLE 3 TYPICAL MACHINERY AND EQUIPMENT USED FOR THE PRODUCTION OF CREAM, CAKE AND ACTIVE DRY YEAST</i> | 19 |
| Investments | 19 |
| <i>FIGURE 2 INVESTMENT COSTS FOR A YEAST PLANT (DRY MATTER EQUIVALENTS) IN RELATIONSHIP TO ANNUAL CAPACITY, 2013 (TONS, DRY YEAST)</i> | 20 |
| Operation | 21 |
| Raw Materials | 21 |
| <i>TABLE 4 TYPICAL RAW MATERIALS AND CHEMICALS REQUIRED FOR THE PRODUCTION OF YEAST (TON/TON YEAST DRY MATTER)</i> | 21 |
| Molasses | 22 |
| <i>TABLE 5 CONSTITUTING ELEMENTS OF DIFFERENT TYPES OF MOLASSES</i> | 22 |
| <i>TABLE 6 USE OF GLOBAL MOLASSES CONSUMPTION SEGMENT, 2013 (MILLION TONS/%)</i> | 23 |
| <i>FIGURE 3 DEVELOPMENT OF GLOBAL MOLASSES PRICES</i> | 23 |
| Other Ingredients | 24 |
| <i>TABLE 7 MATERIAL COSTS FOR A TYPICAL YEAST PLANT, 2013 (\$/TON,%)</i> | 25 |
| LABOR AND UTILITIES | 25 |

| TOPIC | PAGE NO. |
|---|-----------------|
| <i>TABLE 8 TYPICAL UTILITY AND LABOR COSTS FOR A YEAST PLANT IN EUROPE WITH AN ANNUAL CAPACITY OF 10,000 TONS, 2013</i> | 26 |
| <i>TABLE 9 TYPICAL UTILITY AND LABOR COSTS FOR A YEAST PLANT IN ASIA WITH AN ANNUAL CAPACITY OF 10,000 TONS, 2013</i> | 27 |
| TOTAL COSTS OF YEAST PRODUCTION | 27 |
| <i>TABLE 10 TOTAL COSTS OF YEAST PRODUCTION IN EUROPE AND IN ASIA FOR A YEAST PLANT WITH 10,000 TONS CAPACITY, 2013</i> | 27 |
| STANDARD PROCESS FOR PREPARING DIFFERENT YEAST EXTRACTS | 28 |
| <i>TABLE 11 TYPICAL COMPOSITION OF A STANDARD YEAST AUTOLYSATE PREPARED BY THE SALT PROCESS</i> | 28 |
| <i>FIGURE 4 PROCESSING YEAST TO DIFFERENT EXTRACTS</i> | 29 |
| CHAPTER 4 YEAST INDUSTRY STRUCTURES AND MARKETS | 31 |
| BREWER'S YEAST | 31 |
| HISTORIC REVIEW AND BASICS OF BREWING | 31 |
| DEVELOPMENT OF GLOBAL BEER CONSUMPTION | 32 |
| <i>FIGURE 5 DEVELOPMENT OF GLOBAL BEER CONSUMPTION, 1993-2013 (BILLION HECTOLITERS)</i> | 32 |
| <i>TABLE 12 DEVELOPMENT OF PER-CAPITA BEER CONSUMPTION IN SELECTED COUNTRIES, 2008 AND 2013 (LITER/CAPITA)</i> | 33 |
| <i>TABLE 13 GLOBAL BEER CONSUMPTION BY REGION, 2009 AND 2013 (BILLION HECTOLITERS/%)</i> | 33 |
| BEER YEAST CONSUMPTION | 34 |
| <i>TABLE 14 TYPICAL DATA SHEET FOR BEER YEAST</i> | 34 |
| <i>FIGURE 6 DEVELOPMENT OF GLOBAL BEER YEAST CONSUMPTION, 1993-2013 (THOUSAND TONS)</i> | 35 |
| <i>FIGURE 7 GLOBAL COMMERCIALY TRADED BEER YEAST CONSUMPTION BY REGION, 2009 AND 2013 (THOUSAND METRIC TONS)</i> | 35 |
| <i>FIGURE 8 STRUCTURE OF GLOBAL COMMERCIALY TRADED BEER YEAST CONSUMPTION BY REGION, 2013 (%)</i> | 36 |
| PRICE DEVELOPMENTS AND STRUCTURE | 37 |
| SUMMARY FIGURE | 37 |
| <i>FIGURE 9 RELATIONSHIP BETWEEN MOLASSES AND BEER YEAST PRICE (\$/TON)</i> | 37 |
| <i>FIGURE 10 DEVELOPMENT OF GLOBAL BEER YEAST PRICES, 1993-2013 (\$/TON)</i> | 38 |
| MARKET VALUE | 39 |
| <i>TABLE 15 DEVELOPMENT OF THE MARKET VALUE OF BEER YEAST BY REGION, 2009 AND 2013 (\$ MILLIONS/%)</i> | 39 |
| <i>FIGURE 11 STRUCTURE OF MARKET VALUE OF COMMERCIALY TRADED BEER YEAST BY REGION, 2013 (%)</i> | 39 |
| FUTURE DEVELOPMENTS | 40 |
| <i>TABLE 16 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALY TRADED BEER YEAST THROUGH 2019</i> | 41 |
| WINE-MAKING YEAST | 41 |
| HISTORIC REVIEW AND BASICS OF WINE MAKING | 41 |
| DEVELOPMENT OF GLOBAL WINE CONSUMPTION | 43 |
| <i>FIGURE 12 DEVELOPMENT OF GLOBAL WINE CONSUMPTION, 1993-2013 (MILLION TONS)</i> | 43 |
| <i>TABLE 17 TYPICAL PER-CAPITA WINE CONSUMPTION IN SELECTED COUNTRIES 2009 AND 2013 (LITER/CAPITA)</i> | 44 |

| TOPIC | PAGE NO. |
|---|-----------------|
| <i>TABLE 18 DEVELOPMENT OF GLOBAL WINE CONSUMPTION BY REGION, THROUGH 2013 (MILLION METRIC TONS)</i> | 45 |
| <i>FIGURE 13 DEVELOPMENT OF GLOBAL WINE CONSUMPTION AND PRODUCTION, 1993-2013 (MILLION TONS)</i> | 45 |
| <i>FIGURE 14 STRUCTURE OF WINE PRODUCTION BY REGION, 2013 (%)</i> | 46 |
| WINE YEAST CONSUMPTION | 47 |
| <i>FIGURE 15 DEVELOPMENT OF GLOBAL WINE YEAST CONSUMPTION, 1993-2013 (THOUSAND TONS)</i> | 47 |
| <i>TABLE 19 GLOBAL WINE YEAST CONSUMPTION BY REGION, 2013 (MILLION METRIC TONS/%)</i> | 48 |
| <i>FIGURE 16 STRUCTURE OF GLOBAL WINE YEAST CONSUMPTION BY REGION, 2013 (%)</i> | 48 |
| PRICE DEVELOPMENTS AND STRUCTURES | 49 |
| <i>TABLE 20 TYPICAL DATA SHEET FOR WINE YEAST</i> | 49 |
| <i>FIGURE 17 DEVELOPMENT OF WINE YEAST PRICES, 1997-2013 (\$/KG DRY MATERIAL)</i> | 50 |
| MARKET VALUE | 51 |
| <i>FIGURE 18 DEVELOPMENT OF THE MARKET VALUE OF WINE YEAST, 1997-2013 (\$ MILLIONS)</i> | 51 |
| FUTURE DEVELOPMENTS | 51 |
| <i>TABLE 21 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALY TRADED WINE YEAST, THROUGH 2019</i> | 53 |
| YEASTS FOR SPIRITS AND LIQUEURS | 53 |
| PRINCIPLES AND OVERVIEW | 53 |
| DEVELOPMENT OF SPIRIT CONSUMPTION | 54 |
| <i>FIGURE 19 DEVELOPMENT OF SPIRIT CONSUMPTION (EXPRESSED AS PURE ALCOHOL), 1999-2013 (MILLION M3 PURE ALCOHOL)</i> | 55 |
| <i>FIGURE 20 GEOGRAPHIC DISTRIBUTION OF GLOBAL SPIRIT PRODUCTION, 2013 (%)</i> | 56 |
| SPIRITS YEAST CONSUMPTION | 56 |
| <i>FIGURE 21 GEOGRAPHIC DISTRIBUTION OF SPIRIT YEAST CONSUMPTION, BY REGION, 2013 (%)</i> | 57 |
| PRICES AND MARKET VALUE | 58 |
| FUTURE DEVELOPMENTS | 58 |
| <i>TABLE 22 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALY TRADED SPIRITS YEAST THROUGH 2019</i> | 58 |
| BIOETHANOL YEAST | 59 |
| HISTORIC REVIEW AND BASICS OF BIOETHANOL MANUFACTURING | 59 |
| <i>FIGURE 22 PRINCIPLE FLOW CHART FOR GRAIN-BASED BIOETHANOL MANUFACTURING</i> | 60 |
| DEVELOPMENT OF GLOBAL BIOETHANOL PRODUCTION | 61 |
| <i>FIGURE 23 DEVELOPMENT OF GLOBAL BIOETHANOL PRODUCTION, 1998-2013 (MILLION CUBIC METERS)</i> | 61 |
| <i>FIGURE 24 DEVELOPMENT OF ETHANOL PRODUCTION IN SELECTED REGIONS, 2005-2013 (MILLION CUBIC METERS)</i> | 62 |
| YEAST CONSUMPTION FOR BIOETHANOL PRODUCTION | 63 |
| <i>FIGURE 25 DEVELOPMENT OF GLOBAL ETHANOL YEAST CONSUMPTION, 1993-2013 (MILLION CUBIC METERS)</i> | 64 |
| <i>FIGURE 26 GEOGRAPHIC DISTRIBUTION OF ETHANOL YEAST CONSUMPTION, 2013 (%)</i> | 64 |
| PRICE DEVELOPMENTS AND STRUCTURES | 65 |

| TOPIC | PAGE NO. |
|---|-----------------|
| <i>FIGURE 27 PRICE DEVELOPMENT OF ETHANOL YEAST (\$/TON), 1993-2013 (\$/TON)</i> | 65 |
| MARKET VALUE | 66 |
| <i>FIGURE 28 MARKET VALUE OF ETHANOL YEAST BY REGION, 2013 (%)</i> | 66 |
| FUTURE DEVELOPMENTS | 66 |
| <i>TABLE 23 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALY TRADED ETHANOL YEAST THROUGH 2019</i> | 67 |
| BAKER'S YEAST | 68 |
| HISTORIC REVIEW AND BASICS OF BAKING | 68 |
| DEVELOPMENT OF GLOBAL BREAD CONSUMPTION | 69 |
| <i>TABLE 24 BREAD CONSUMPTION BY SELECTED EUROPEAN COUNTRIES, 2008 AND 2013 (KG/CAPITA)</i> | 69 |
| <i>FIGURE 29 DEVELOPMENT OF PER-CAPITA BREAD CONSUMPTION IN THE U.S. 1960-2013 (KG PER CAPITA)</i> | 70 |
| <i>FIGURE 30 STRUCTURE OF GLOBAL BREAD CONSUMPTION 2013 (%)</i> | 72 |
| BAKER'S YEAST CONSUMPTION | 73 |
| <i>TABLE 25 TYPICAL DATA SHEET FOR INSTANT DRY BAKER'S YEAST</i> | 74 |
| <i>TABLE 26 STRUCTURE OF GLOBAL BAKERY YEAST CONSUMPTION, 2013</i> | 74 |
| <i>FIGURE 31 STRUCTURE OF GLOBAL BAKER'S YEAST CONSUMPTION, 2013 (%)</i> | 75 |
| <i>FIGURE 32 DEVELOPMENT OF BAKER'S YEAST CONSUMPTION, 1993-2013 (THOUSAND METRIC TONS)</i> | 75 |
| PRICE DEVELOPMENT AND STRUCTURES | 76 |
| <i>FIGURE 33 DEVELOPMENT OF GLOBAL BAKER'S YEAST PRICES, 1993-2013 (%/TON)</i> | 77 |
| MARKET VALUE | 78 |
| <i>FIGURE 34 STRUCTURE OF BAKER'S YEAST MARKET VALUE BY REGION, 2013 (\$ MILLIONS)</i> | 78 |
| FUTURE DEVELOPMENTS | 78 |
| <i>TABLE 27 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALY TRADED BAKER'S YEAST, THROUGH 2019</i> | 79 |
| FEED YEASTS | 80 |
| CLASSIFICATION AND OVERVIEW | 80 |
| <i>FIGURE 35 CLASSIFICATION OF FEED YEASTS</i> | 80 |
| YEASTS AS BYPRODUCTS FROM INDUSTRIAL PROCESSES | 80 |
| Spent brewer's yeast | 80 |
| <i>TABLE 28 TYPICAL COMPOSITION OF SPENT BREWER'S YEAST (%)</i> | 81 |
| Torula Yeast | 81 |
| Yeast as a Residue from Ethanol Production Processes | 82 |
| <i>TABLE 29 TYPICAL COMPOSITION OF FRESH VINASSE FROM ETHANOL PRODUCTION</i> | 82 |
| Other Yeast as Residue Form Agro-Industrial Processes | 82 |
| DEVELOPMENT OF CONSUMPTION | 83 |
| <i>TABLE 30 PRODUCTION OF YEAST DERIVED AS BYPRODUCT FROM INDUSTRIAL PROCESSES AND USED IN THE FEEDING INDUSTRY, 2013 (MILLION METRIC TONS/%)</i> | 84 |
| <i>FIGURE 36 CONSUMPTION OF YEAST DERIVED AS BYPRODUCTS FROM INDUSTRIAL PROCESSES BY REGION, 2013 (%)</i> | 85 |
| PRICE DEVELOPMENTS | 85 |
| MARKET VALUE | 85 |
| <i>TABLE 31 MARKET VALUE OF YEAST DERIVED AS A BYPRODUCT OF INDUSTRIAL PROCESSES, 2013 (\$ MILLIONS)</i> | 86 |

| TOPIC | PAGE NO. |
|---|-----------------|
| <i>FIGURE 37 MARKET VALUE OF YEAST DERIVED AS A BYPRODUCT OF INDUSTRIAL PROCESSES, BY REGION 2013</i> | 86 |
| FUTURE DEVELOPMENT | 87 |
| <i>TABLE 32 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALY TRADED YEAST AS BYPRODUCT FROM INDUSTRIAL PROCESSES, THROUGH 2019</i> | 87 |
| ACTIVE (LIVE) YEASTS | 87 |
| PRODUCT CHARACTERISTICS | 87 |
| <i>TABLE 33 TYPICAL DATA SHEET OF AN ACTIVE LIVE YEAST CULTURE PRODUCT</i> | 88 |
| DEVELOPMENT OF CONSUMPTION | 89 |
| <i>FIGURE 38 DEVELOPMENT OF LIVE FEED YEAST PRODUCT CONSUMPTION, 1993-2013 (1,000 TONS)</i> | 89 |
| <i>FIGURE 39 CONSUMPTION OF LIVE FEED YEAST PRODUCTS BY REGION, 2013 (%)</i> | 90 |
| PRICE DEVELOPMENT | 90 |
| MARKET VALUE | 91 |
| <i>TABLE 34 STRUCTURE OF LIVE FEED YEAST MARKET VALUE BY REGION, 2013</i> | 91 |
| FUTURE DEVELOPMENTS | 91 |
| <i>TABLE 35 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALY TRADED LIVE YEASTS, THROUGH 2019</i> | 92 |
| MINERAL YEASTS AND PROTEINATES | 92 |
| PRODUCT CHARACTERISTICS | 92 |
| <i>TABLE 36 TYPICAL CHARACTERISTICS OF SELECTED MINERAL YEASTS</i> | 94 |
| DEVELOPMENT OF CONSUMPTION | 94 |
| <i>TABLE 37 DEVELOPMENT OF GLOBAL CONSUMPTION OF MINERAL YEASTS AND PROTEINATES, 1990-2013 (THOUSAND TONS)</i> | 95 |
| <i>FIGURE 40 STRUCTURE OF CONSUMPTION BY TYPE OF FEED MINERAL YEAST, 2013 (%)</i> | 95 |
| <i>FIGURE 41 GEOGRAPHICAL STRUCTURE OF MINERAL YEAST CONSUMPTION, 2013 (%)</i> | 96 |
| PRICE DEVELOPMENT | 97 |
| MARKET VALUE | 97 |
| <i>TABLE 38 MINERAL YEAST MARKET VALUE BY REGION, 2013 (\$ MILLIONS/%)</i> | 97 |
| FUTURE DEVELOPMENTS | 97 |
| <i>TABLE 39 DEVELOPMENT OF MARKET STRUCTURE FOR MINERAL YEAST, THROUGH 2019</i> | 98 |
| YEASTS AS FOOD SUPPLEMENTS | 98 |
| CLASSIFICATION AND OVERVIEW | 98 |
| <i>TABLE 40 CHARACTERISTICS OF TYPICALLY AVAILABLE FOOD SUPPLEMENT YEAST PRODUCTS</i> | 99 |
| DEVELOPMENT OF CONSUMPTION | 99 |
| <i>FIGURE 42 DEVELOPMENT OF CONSUMPTION OF FOOD SUPPLEMENT YEASTS BY TYPE OF PRODUCT, 1990-2013 (THOUSAND TONS)</i> | 100 |
| <i>FIGURE 43 FOOD SUPPLEMENT YEAST CONSUMPTION BY REGION, 2013 (%)</i> | 100 |
| PRICE DEVELOPMENTS | 101 |
| <i>FIGURE 44 DISTRIBUTION AND VALUE CHAINS FOR FOOD SUPPLEMENT YEASTS</i> | 102 |
| MARKET VALUE | 103 |
| <i>FIGURE 45 STRUCTURE OF FOOD SUPPLEMENT YEAST MARKET VALUE (\$92.4 MILLION) BY TYPE OF PRODUCT, 2013 (%)</i> | 103 |
| <i>FIGURE 46 STRUCTURE OF FOOD SUPPLEMENT YEAST MARKET VALUE BY REGION, 2013 (%)</i> | 103 |
| FUTURE DEVELOPMENTS | 104 |

| TOPIC | PAGE NO. |
|---|-----------------|
| <i>TABLE 41 DEVELOPMENT OF MARKET STRUCTURE FOR FOOD SUPPLEMENTS, THROUGH 2019</i> | 105 |
| PRODUCTS FROM THE DECOMPOSITION OF YEAST CELLS | 105 |
| MANNAN OLIGOSACCHARIDES | 106 |
| Characterization and Overview | 106 |
| <i>TABLE 42 BACTERIA SUPPRESSED AND PROMOTED BY MANNAN OLIGOSACCHARIDES IN THE DIGESTIVE TRACT OF MONOGASTRIC ANIMALS</i> | 107 |
| <i>TABLE 43 TYPICAL DATA SHEET OF A MANNAN-GLUCAN OLIGOSACCHARIDE FEED ADDITIVE PRODUCT</i> | 107 |
| Development of Consumption | 107 |
| <i>FIGURE 47 DEVELOPMENT OF CONSUMPTION OF MANNAN OLIGOSACCHARIDES, 1990-2013 (THOUSAND TONS)</i> | 108 |
| <i>FIGURE 48 REGIONAL STRUCTURE OF MANNAN-OLIGOSACCHARIDE CONSUMPTION, 2013 (%)</i> | 108 |
| Price Developments | 109 |
| Market Value | 109 |
| Future Development | 110 |
| <i>TABLE 44 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALY TRADED MANNAN OLIGOSACCHARIDES THROUGH 2019</i> | 110 |
| BETA-GLUCANS | 110 |
| Characteristics and Overview | 110 |
| <i>FIGURE 49 POSSIBLE MODE OF ACTION OF BETA-GLUCANS</i> | 110 |
| <i>TABLE 45 POTENTIAL FIELDS OF APPLICATION OF BETA-GLUCANS</i> | 111 |
| <i>TABLE 46 TYPICAL ANALYTICAL DATA OF COMMERCIAL GLUCAN PRODUCTS FOR FOOD AND FEED USE</i> | 112 |
| Development of Consumption | 112 |
| <i>FIGURE 50 DEVELOPMENT OF CONSUMPTION OF BETA-GLUCAN PRODUCTS, 1990-2013 (THOUSAND TONS)</i> | 112 |
| Price development | 113 |
| Market Value | 114 |
| Future Development | 114 |
| <i>TABLE 47 DEVELOPMENT OF MARKET STRUCTURE FOR YEAST BASED BETA-GLUCAN PRODUCTS, THROUGH 2019</i> | 114 |
| YEAST EXTRACTS AND AUTOLYSATES | 114 |
| CHARACTERISTICS AND OVERVIEW | 114 |
| <i>TABLE 48 AMINO ACID, VITAMIN AND MINERAL CONTENT OF TYPICAL AUTOLYSATES FOR FERMENTATION</i> | 115 |
| FLAVOR ENHANCING | 116 |
| <i>TABLE 49 TYPICAL ANALYTICAL DATA SHEET OF FLAVOR ENHANCING AUTOLYSATES (%)</i> | 116 |
| <i>TABLE 50 TYPICAL APPLICATIONS OF AUTOLYSATES AS FLAVOR ENHANCERS IN FOODS AND PET FOODS (%)</i> | 117 |
| <i>TABLE 51 TYPICAL EFFECTS OBTAINED FROM THE ADDITION OF YEAST EXTRACTS TO FOOD PRODUCTS</i> | 117 |
| DEVELOPMENT OF CONSUMPTION | 118 |
| <i>FIGURE 51 DEVELOPMENT AND STRUCTURE OF YEAST EXTRACT CONSUMPTION 1990-2013 (THOUSAND TONS)</i> | 118 |
| <i>FIGURE 52 REGIONAL STRUCTURE OF AUTOLYSATE CONSUMPTION AS FLAVOR ENHANCER, 2013 (%)</i> | 118 |

| TOPIC | PAGE NO. |
|--|-----------------|
| <i>FIGURE 53 REGIONAL STRUCTURE OF AUTOLYSATE CONSUMPTION AS FERMENTATION ENHANCER, 2013 (%)</i> | 119 |
| PRICE DEVELOPMENTS | 120 |
| MARKET VALUE | 120 |
| <i>FIGURE 54 MARKET VALUE (\$425 MILLION) OF YEAST EXTRACTS BY REGION, 2013 (%)</i> | 120 |
| FUTURE DEVELOPMENTS | 121 |
| <i>TABLE 52 DEVELOPMENT OF MARKET STRUCTURE FOR YEAST AUTOLYSATES, THROUGH 2019</i> | 122 |
| YEAST INDUSTRY STRUCTURE | 122 |
| COMPETITIVE ENVIRONMENT | 122 |
| REGIONAL DISTRIBUTION OF YEAST FACTORIES | 124 |
| <i>FIGURE 55 REGIONAL DISTRIBUTION OF THE NUMBER OF YEAST PLANTS, 2013 (%)</i> | 124 |
| <i>TABLE 53 REGIONAL DISTRIBUTION OF YEAST PRODUCTION, 2013 (THOUSAND TONS)</i> | 125 |
| <i>FIGURE 56 MARKET SHARES OF YEAST PRODUCERS, 2013 (%)</i> | 125 |
| VALUE CHAINS AND MASS FLOWS | 126 |
| <i>FIGURE 57 MASS FLOWS FOR THE TRANSFORMATION OF CARBOHYDRATES INTO DIFFERENT YEAST PRODUCTS 2013</i> | 127 |
| <i>FIGURE 58 FINANCIAL FLOWS FOR THE TRANSFORMATION OF CARBOHYDRATES INTO DIFFERENT YEAST PRODUCTS 2013, (\$ MILLIONS)</i> | 128 |
| COMPANY PROFILES | 128 |
| AB MAURI FLEISCHMANN'S | 128 |
| ALLTECH | 129 |
| ANGEL YEAST CO., LTD. | 129 |
| DIAMOND V | 130 |
| LALLEMAND | 130 |
| LEIBER GMBH | 131 |
| LESAFFRE | 131 |
| ORIENTAL YEAST COMPANY | 132 |
| PAKMAYA | 132 |

LIST OF TABLES

| TABLE HEADING | PAGE NO. |
|--|-----------------|
| SUMMARY TABLE GLOBAL MARKET VALUE FOR YEAST PRODUCTS, BY TYPE, THROUGH 2019 (\$ MILLIONS) | 8 |
| TABLE 1 CARBOHYDRATE SOURCE ALTERNATIVES TO MOLASSES BY TYPE OF YEAST | 12 |
| TABLE 2 ` PROPERTIES OF COMMERCIAL YEAST FORMS | 16 |
| TABLE 3 TYPICAL MACHINERY AND EQUIPMENT USED FOR THE PRODUCTION OF CREAM, CAKE AND ACTIVE DRY YEAST | 19 |
| TABLE 4 TYPICAL RAW MATERIALS AND CHEMICALS REQUIRED FOR THE PRODUCTION OF YEAST (TON/TON YEAST DRY MATTER) | 21 |
| TABLE 5 CONSTITUTING ELEMENTS OF DIFFERENT TYPES OF MOLASSES | 22 |
| TABLE 6 USE OF GLOBAL MOLASSES CONSUMPTION SEGMENT, 2013 (MILLION TONS/%) | 23 |
| TABLE 7 MATERIAL COSTS FOR A TYPICAL YEAST PLANT, 2013 (\$/TON,%) | 25 |
| TABLE 8 TYPICAL UTILITY AND LABOR COSTS FOR A YEAST PLANT IN EUROPE WITH AN ANNUAL CAPACITY OF 10,000 TONS, 2013 | 26 |
| TABLE 9 TYPICAL UTILITY AND LABOR COSTS FOR A YEAST PLANT IN ASIA WITH AN ANNUAL CAPACITY OF 10,000 TONS, 2013 | 27 |
| TABLE 10 TOTAL COSTS OF YEAST PRODUCTION IN EUROPE AND IN ASIA FOR A YEAST PLANT WITH 10,000 TONS CAPACITY, 2013 | 27 |
| TABLE 11 TYPICAL COMPOSITION OF A STANDARD YEAST AUTOLYSATE PREPARED BY THE SALT PROCESS | 28 |
| TABLE 12 DEVELOPMENT OF PER-CAPITA BEER CONSUMPTION IN SELECTED COUNTRIES, 2008 AND 2013 (LITER/CAPITA) | 33 |
| TABLE 13 GLOBAL BEER CONSUMPTION BY REGION, 2009 AND 2013 (BILLION HECTOLITERS/%) | 33 |
| TABLE 14 TYPICAL DATA SHEET FOR BEER YEAST | 34 |
| TABLE 15 DEVELOPMENT OF THE MARKET VALUE OF BEER YEAST BY REGION, 2009 AND 2013 (\$ MILLIONS/%) | 39 |
| TABLE 16 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALY TRADED BEER YEAST THROUGH 2019 | 41 |
| TABLE 17 TYPICAL PER-CAPITA WINE CONSUMPTION IN SELECTED COUNTRIES 2009 AND 2013 (LITER/CAPITA) | 44 |
| TABLE 18 DEVELOPMENT OF GLOBAL WINE CONSUMPTION BY REGION, THROUGH 2013 (MILLION METRIC TONS) | 45 |
| TABLE 19 GLOBAL WINE YEAST CONSUMPTION BY REGION, 2013 (MILLION METRIC TONS/%) | 48 |
| TABLE 20 TYPICAL DATA SHEET FOR WINE YEAST | 49 |
| TABLE 21 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALY TRADED WINE YEAST, THROUGH 2019 | 53 |
| TABLE 22 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALY TRADED SPIRITS YEAST THROUGH 2019 | 58 |
| TABLE 23 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALY TRADED ETHANOL YEAST THROUGH 2019 | 67 |
| TABLE 24 BREAD CONSUMPTION BY SELECTED EUROPEAN COUNTRIES, 2008 AND 2013 (KG/CAPITA) | 69 |
| TABLE 25 TYPICAL DATA SHEET FOR INSTANT DRY BAKER'S YEAST | 74 |
| TABLE 26 STRUCTURE OF GLOBAL BAKERY YEAST CONSUMPTION, 2013 | 74 |
| TABLE 27 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALY TRADED BAKER'S YEAST, THROUGH 2019 | 79 |
| TABLE 28 TYPICAL COMPOSITION OF SPENT BREWER'S YEAST (%) | 81 |
| TABLE 29 TYPICAL COMPOSITION OF FRESH VINASSE FROM ETHANOL PRODUCTION | 82 |

| TABLE HEADING | PAGE NO. |
|--|-----------------|
| TABLE 30 PRODUCTION OF YEAST DERIVED AS BYPRODUCT FROM INDUSTRIAL PROCESSES AND USED IN THE FEEDING INDUSTRY, 2013 (MILLION METRIC TONS/%) | 84 |
| TABLE 31 MARKET VALUE OF YEAST DERIVED AS A BYPRODUCT OF INDUSTRIAL PROCESSES, 2013 (\$ MILLIONS) | 86 |
| TABLE 32 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALLY TRADED YEAST AS BYPRODUCT FROM INDUSTRIAL PROCESSES, THROUGH 2019 | 87 |
| TABLE 33 TYPICAL DATA SHEET OF AN ACTIVE LIVE YEAST CULTURE PRODUCT | 88 |
| TABLE 34 STRUCTURE OF LIVE FEED YEAST MARKET VALUE BY REGION, 2013 | 91 |
| TABLE 35 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALLY TRADED LIVE YEASTS, THROUGH 2019 | 92 |
| TABLE 36 TYPICAL CHARACTERISTICS OF SELECTED MINERAL YEASTS | 94 |
| TABLE 37 DEVELOPMENT OF GLOBAL CONSUMPTION OF MINERAL YEASTS AND PROTEINATES, 1990-2013 (THOUSAND TONS) | 95 |
| TABLE 38 MINERAL YEAST MARKET VALUE BY REGION, 2013 (\$ MILLIONS/%) | 97 |
| TABLE 39 DEVELOPMENT OF MARKET STRUCTURE FOR MINERAL YEAST, THROUGH 2019 | 98 |
| TABLE 40 CHARACTERISTICS OF TYPICALLY AVAILABLE FOOD SUPPLEMENT YEAST PRODUCTS | 99 |
| TABLE 41 DEVELOPMENT OF MARKET STRUCTURE FOR FOOD SUPPLEMENTS, THROUGH 2019 | 105 |
| TABLE 42 BACTERIA SUPPRESSED AND PROMOTED BY MANNAN OLIGOSACCHARIDES IN THE DIGESTIVE TRACT OF MONOGASTRIC ANIMALS | 107 |
| TABLE 43 TYPICAL DATA SHEET OF A MANNAN-GLUCAN OLIGOSACCHARIDE FEED ADDITIVE PRODUCT | 107 |
| TABLE 44 DEVELOPMENT OF MARKET STRUCTURE FOR COMMERCIALLY TRADED MANNAN OLIGOSACCHARIDES THROUGH 2019 | 110 |
| TABLE 45 POTENTIAL FIELDS OF APPLICATION OF BETA-GLUCANS | 111 |
| TABLE 46 TYPICAL ANALYTICAL DATA OF COMMERCIAL GLUCAN PRODUCTS FOR FOOD AND FEED USE | 112 |
| TABLE 47 DEVELOPMENT OF MARKET STRUCTURE FOR YEAST BASED BETA-GLUCAN PRODUCTS, THROUGH 2019 | 114 |
| TABLE 48 AMINO ACID, VITAMIN AND MINERAL CONTENT OF TYPICAL AUTOLYSATES FOR FERMENTATION | 115 |
| TABLE 49 TYPICAL ANALYTICAL DATA SHEET OF FLAVOR ENHANCING AUTOLYSATES (%) | 116 |
| TABLE 50 TYPICAL APPLICATIONS OF AUTOLYSATES AS FLAVOR ENHANCERS IN FOODS AND PET FOODS (%) | 117 |
| TABLE 51 TYPICAL EFFECTS OBTAINED FROM THE ADDITION OF YEAST EXTRACTS TO FOOD PRODUCTS | 117 |
| TABLE 52 DEVELOPMENT OF MARKET STRUCTURE FOR YEAST AUTOLYSATES, THROUGH 2019 | 122 |
| TABLE 53 REGIONAL DISTRIBUTION OF YEAST PRODUCTION, 2013 (THOUSAND TONS) | 125 |

LIST OF FIGURES

| FIGURE TITLE | PAGE NO. |
|---|-----------------|
| FIGURE 01 MARKET VALUE OF YEAST PRODUCTS BY REGION, 2013 (\$ MILLIONS) | 8 |
| FIGURE 02 RELEVANCE OF APPLICATION SECTORS FOR THE GLOBAL YEAST MARKETS, 2013 (%) | 9 |
| FIGURE 03 GLOBAL MARKET VALUE FOR YEAST PRODUCTS, BY TYPE, 2013 AND 2019 (\$ MILLIONS) | 9 |
| FIGURE 1 FLOW CHART FOR THE PRODUCTION OF YEAST BIOMASS | 16 |
| FIGURE 2 INVESTMENT COSTS FOR A YEAST PLANT (DRY MATTER EQUIVALENTS) IN RELATIONSHIP TO ANNUAL CAPACITY, 2013 (TONS, DRY YEAST) | 20 |
| FIGURE 3 DEVELOPMENT OF GLOBAL MOLASSES PRICES | 23 |
| FIGURE 4 PROCESSING YEAST TO DIFFERENT EXTRACTS | 29 |
| FIGURE 5 DEVELOPMENT OF GLOBAL BEER CONSUMPTION, 1993-2013 (BILLION HECTOLITERS) | 32 |
| FIGURE 6 DEVELOPMENT OF GLOBAL BEER YEAST CONSUMPTION, 1993-2013 (THOUSAND TONS) | 35 |
| FIGURE 7 GLOBAL COMMERCIALY TRADED BEER YEAST CONSUMPTION BY REGION, 2009 AND 2013 (THOUSAND METRIC TONS) | 35 |
| FIGURE 8 STRUCTURE OF GLOBAL COMMERCIALY TRADED BEER YEAST CONSUMPTION BY REGION, 2013 (%) | 36 |
| SUMMARY FIGURE | 37 |
| FIGURE 9 RELATIONSHIP BETWEEN MOLASSES AND BEER YEAST PRICE (\$/TON) | 37 |
| FIGURE 10 DEVELOPMENT OF GLOBAL BEER YEAST PRICES, 1993-2013 (\$/TON) | 38 |
| FIGURE 11 STRUCTURE OF MARKET VALUE OF COMMERCIALY TRADED BEER YEAST BY REGION, 2013 (%) | 39 |
| FIGURE 12 DEVELOPMENT OF GLOBAL WINE CONSUMPTION, 1993-2013 (MILLION TONS) | 43 |
| FIGURE 13 DEVELOPMENT OF GLOBAL WINE CONSUMPTION AND PRODUCTION, 1993-2013 (MILLION TONS) | 45 |
| FIGURE 14 STRUCTURE OF WINE PRODUCTION BY REGION, 2013 (%) | 46 |
| FIGURE 15 DEVELOPMENT OF GLOBAL WINE YEAST CONSUMPTION, 1993-2013 (THOUSAND TONS) | 47 |
| FIGURE 16 STRUCTURE OF GLOBAL WINE YEAST CONSUMPTION BY REGION, 2013 (%) | 48 |
| FIGURE 17 DEVELOPMENT OF WINE YEAST PRICES, 1997-2013 (\$/KG DRY MATERIAL) | 50 |
| FIGURE 18 DEVELOPMENT OF THE MARKET VALUE OF WINE YEAST, 1997-2013 (\$ MILLIONS) | 51 |
| FIGURE 19 DEVELOPMENT OF SPIRIT CONSUMPTION (EXPRESSED AS PURE ALCOHOL), 1999-2013 (MILLION M3 PURE ALCOHOL) | 55 |
| FIGURE 20 GEOGRAPHIC DISTRIBUTION OF GLOBAL SPIRIT PRODUCTION, 2013 (%) | 56 |
| FIGURE 21 GEOGRAPHIC DISTRIBUTION OF SPIRIT YEAST CONSUMPTION, BY REGION, 2013 (%) | 57 |
| FIGURE 22 PRINCIPLE FLOW CHART FOR GRAIN-BASED BIOETHANOL MANUFACTURING | 60 |
| FIGURE 23 DEVELOPMENT OF GLOBAL BIOETHANOL PRODUCTION, 1998-2013 (MILLION CUBIC METERS) | 61 |
| FIGURE 24 DEVELOPMENT OF ETHANOL PRODUCTION IN SELECTED REGIONS, 2005-2013 (MILLION CUBIC METERS) | 62 |
| FIGURE 25 DEVELOPMENT OF GLOBAL ETHANOL YEAST CONSUMPTION, 1993-2013 (MILLION CUBIC METERS) | 64 |
| FIGURE 26 GEOGRAPHIC DISTRIBUTION OF ETHANOL YEAST CONSUMPTION, 2013 (%) | 64 |

| FIGURE TITLE | PAGE NO. |
|--|-----------------|
| FIGURE 27 PRICE DEVELOPMENT OF ETHANOL YEAST (\$/TON), 1993-2013 (\$/TON) | 65 |
| FIGURE 28 MARKET VALUE OF ETHANOL YEAST BY REGION, 2013 (%) | 66 |
| FIGURE 29 DEVELOPMENT OF PER-CAPITA BREAD CONSUMPTION IN THE U.S. 1960-2013 (KG PER CAPITA) | 70 |
| FIGURE 30 STRUCTURE OF GLOBAL BREAD CONSUMPTION 2013 (%) | 72 |
| FIGURE 31 STRUCTURE OF GLOBAL BAKER'S YEAST CONSUMPTION, 2013 (%) | 75 |
| FIGURE 32 DEVELOPMENT OF BAKER'S YEAST CONSUMPTION, 1993-2013 (THOUSAND METRIC TONS) | 75 |
| FIGURE 33 DEVELOPMENT OF GLOBAL BAKER'S YEAST PRICES, 1993-2013 (%/TON) | 77 |
| FIGURE 34 STRUCTURE OF BAKER'S YEAST MARKET VALUE BY REGION, 2013 (\$ MILLIONS) | 78 |
| FIGURE 35 CLASSIFICATION OF FEED YEASTS | 80 |
| FIGURE 36 CONSUMPTION OF YEAST DERIVED AS BYPRODUCTS FROM INDUSTRIAL PROCESSES BY REGION, 2013 (%) | 85 |
| FIGURE 37 MARKET VALUE OF YEAST DERIVED AS A BYPRODUCT OF INDUSTRIAL PROCESSES, BY REGION 2013 | 86 |
| FIGURE 38 DEVELOPMENT OF LIVE FEED YEAST PRODUCT CONSUMPTION, 1993-2013 (1,000 TONS) | 89 |
| FIGURE 39 CONSUMPTION OF LIVE FEED YEAST PRODUCTS BY REGION, 2013 (%) | 90 |
| FIGURE 40 STRUCTURE OF CONSUMPTION BY TYPE OF FEED MINERAL YEAST, 2013 (%) | 95 |
| FIGURE 41 GEOGRAPHICAL STRUCTURE OF MINERAL YEAST CONSUMPTION, 2013 (%) | 96 |
| FIGURE 42 DEVELOPMENT OF CONSUMPTION OF FOOD SUPPLEMENT YEASTS BY TYPE OF PRODUCT, 1990-2013 (THOUSAND TONS) | 100 |
| FIGURE 43 FOOD SUPPLEMENT YEAST CONSUMPTION BY REGION, 2013 (%) | 100 |
| FIGURE 44 DISTRIBUTION AND VALUE CHAINS FOR FOOD SUPPLEMENT YEASTS | 102 |
| FIGURE 45 STRUCTURE OF FOOD SUPPLEMENT YEAST MARKET VALUE (\$92.4 MILLION) BY TYPE OF PRODUCT, 2013 (%) | 103 |
| FIGURE 46 STRUCTURE OF FOOD SUPPLEMENT YEAST MARKET VALUE BY REGION, 2013 (%) | 103 |
| FIGURE 47 DEVELOPMENT OF CONSUMPTION OF MANNAN OLIGOSACCHARIDES, 1990-2013 (THOUSAND TONS) | 108 |
| FIGURE 48 REGIONAL STRUCTURE OF MANNAN-OLIGOSACCHARIDE CONSUMPTION, 2013 (%) | 108 |
| FIGURE 49 POSSIBLE MODE OF ACTION OF BETA-GLUCANS | 110 |
| FIGURE 50 DEVELOPMENT OF CONSUMPTION OF BETA-GLUCAN PRODUCTS, 1990-2013 (THOUSAND TONS) | 112 |
| FIGURE 51 DEVELOPMENT AND STRUCTURE OF YEAST EXTRACT CONSUMPTION 1990-2013 (THOUSAND TONS) | 118 |
| FIGURE 52 REGIONAL STRUCTURE OF AUTOLYSATE CONSUMPTION AS FLAVOR ENHANCER, 2013 (%) | 118 |
| FIGURE 53 REGIONAL STRUCTURE OF AUTOLYSATE CONSUMPTION AS FERMENTATION ENHANCER, 2013 (%) | 119 |
| FIGURE 54 MARKET VALUE (\$425 MILLION) OF YEAST EXTRACTS BY REGION, 2013 (%) | 120 |
| FIGURE 55 REGIONAL DISTRIBUTION OF THE NUMBER OF YEAST PLANTS, 2013 (%) | 124 |
| FIGURE 56 MARKET SHARES OF YEAST PRODUCERS, 2013 (%) | 125 |
| FIGURE 57 MASS FLOWS FOR THE TRANSFORMATION OF CARBOHYDRATES INTO DIFFERENT YEAST PRODUCTS 2013 | 127 |

| FIGURE TITLE | PAGE NO. |
|---|-----------------|
| FIGURE 58 FINANCIAL FLOWS FOR THE TRANSFORMATION OF CARBOHYDRATES INTO DIFFERENT YEAST PRODUCTS 2013, (\$ MILLIONS) | 128 |