

MULTICLIENT STUDY

Enzymes for the Food/Drink & Animal Feed Industries

Supply/Demand & Competitive Strengths

2015-2020

June 2016

Products



Bread | Noodles | Rice wine | Soy sauce | Vinegar | Beer | Fruit Processing



Bakery/Cereals
Alcoholic drinks
Fruit processing
Dairy
Protein hydrolysis
Animal feed

Markets



USA

EU28

China

India



Transnational Business Research & Consultancy



Enzymes, the largest class of proteins, are biocatalysts. Over 2000 different kinds are known, each catalysing a different chemical reaction. Use of enzymes in food/drink and animal feed is growing due to their effectiveness and specificity of enzymes in promoting chemical reactions. In the USA and in Europe bakery is currently one of the most interesting markets for enzyme suppliers. Enzymes are considered "natural" and can be treated as "processing aids" (may change in Europe), so there is considerable interest in enzymes as a means to develop "clean label" baked-goods. However, persistent questions on genetic modification, particularly in Europe, have been a major stumbling block for many high-performance enzymes.

China has emerged as an extremely important market in view of its position as global leader in beer and apple juice concentrate production. Enzymes have been widely used in the Chinese beer industry for a long time and technological advances in China, adapting enzymes to various applications including traditional Chinese food have given an impetus to the market there.

India is a growing hub of food processing, and has seen rapid growth in all sectors including brewing and fruit processing. India is also emerging as a significant producer of enzymes with many biotechnology companies setting up their production facilities.

Protein hydrolysis and modification represent a major opportunity for enzyme producers with growing demands for speciality enzymes.

Animal feed is a vast and growing market for enzymes.

Giract has been following the global enzymes market for many years now. Its first study of the market in China was 2001. It examined the global market for bakery enzymes market in 2007 and more recently in 2013. Confidential projects on enzyme markets globally have added to Giract's knowledge of these ingredients. The current study will provide a comprehensive coverage of food and feed enzyme production and use in the key global markets.

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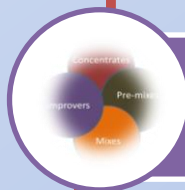
Enzymes for the Food/Drink Industry - Supply/Demand & Competitive Strengths



To identify supply, demand and trends for selected enzymes in food/drink and animal feed



To examine the factors for and against change and the impact which these have on enzyme use by food, drink and animal feed producers



An evaluation of the impact of market trends such as clean-label and the acceptance of enzymes produced using GM-organisms



An identification of the current (2015) market size by product group, sector, country, and forecasts of volumes and value for 2020

This unique study examines enzymes supply, demand and forecasts – USA, EU28, China and India

SCOPE

Products



- **Bakery/Cereals:** flour, bread, noodles...
- **Alcoholic drinks:** beer, wine-making, distilled liquor
- **Fruit processing**
- **Dairy**
- **Protein hydrolysis:** HVP/HAP, Fish sauce, Nucleotides, Protein derivatives
- **Animal feed (including aquaculture)**

Markets



- **USA**
- **EU28**
- **China**
- **India**

STUDY HIGHLIGHT

Programme

Following an initial review of Giract's comprehensive in-house database, in-depth interviews were carried out with major players (producers, blenders and users). The study provides an in-depth understanding of the enzymes used, and factors for and against use of enzymes in the various end-use markets.

Current: 2015
Forecast: 2020

Timescale



WHAT DO YOU GET?

1. **Electronic Copy** of report in searchable PDF format
2. **One Printed Copy**



3. Report published in **June 2016**

An analysis of enzymes for the bakery sector has been carried out on a global scale. In addition, confidential work on enzymes has ranged from ELISA diagnostics to cheese and yogurt starter cultures as well as consideration of amylases, phytase and various lipases.

Report title	Geographical scope	Timescale
Opportunities for Enzymes in the Bakery Value Chain – Selected Countries	USA, Mexico, Argentina, Brazil, Chile, UK, France, Germany, Romania, Algeria, Egypt, Morocco, Nigeria, Sudan, Saudi Arabia, Turkey, Iran, Russia, Belarus, Ukraine, Kazakhstan, Uzbekistan, China, India, Pakistan, Thailand, Vietnam, Indonesia, Philippines, Australia	2011
Bakery Intermediates Supply/Demand & Competitive Strengths	European Union-28 (with a detailed analysis of Germany, France, UK, Italy, Netherlands, Spain, Poland and Belgium), USA/Canada	2013-2020
Enzymes for the Food/drink & feed industry Supply/demand forecasts	China	2001-2010

MULTICLIENT REPORT

June 2016

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CONTENTS

1.	INTRODUCTION	21
1.1.	SCOPE	22
2.	EXECUTIVE SUMMARY	23
2.1.	INTRODUCTION	23
2.1.1.	GLOBAL ENZYME MARKET.....	24
2.1.1.1	FOOD & BEVERAGES.....	25
2.1.1.2	ANIMAL FEED.....	26
2.2.	SUPPLY	27
2.2.1.	PRODUCTION	27
2.2.2.	GLOBAL SUPPLIERS	28
2.2.2.1	AB ENZYMES.....	28
2.2.2.2	AMANO	29
2.2.2.3	BASF.....	29
2.2.2.4	DSM.....	30
2.2.2.5	DUPONT.....	31
2.2.2.6	NOVOZYMES.....	32
2.2.3.	OTHER PRODUCERS.....	33
2.2.3.1	CHINA	34
2.2.3.2	INDIA.....	39
2.2.4.	TECHNOLOGY PROVIDERS	40
2.2.5.	ENZYME DISTRIBUTORS & FORMULATORS	42
2.3.	ENZYME USE IN FOOD & BEVERAGES	43
2.3.1.	BAKERY & CEREALS	44
2.3.1.1	MARKET OVERVIEW	44
2.3.1.2	ENZYME APPLICATIONS	45
2.3.1.3	FUTURE TRENDS.....	45
2.3.2.	BREWING, WINE MAKING & DISTILLED ALCOHOLIC BEVERAGES.....	46
2.3.2.1	MARKET SIZE	46
2.3.2.2	ENZYME APPLICATIONS	48
2.3.2.3	FUTURE TRENDS.....	49
2.3.3.	FRUIT PROCESSING.....	50
2.3.3.1	MARKET SIZE	50
2.3.3.2	ENZYME APPLICATIONS	51
2.3.3.3	FUTURE TRENDS.....	51
2.3.4.	DAIRY	52
2.3.4.1	MARKET SIZE	52
2.3.4.2	ENZYME APPLICATIONS	52
2.3.4.3	FUTURE TRENDS.....	53
2.3.5.	PROTEIN HYDROLYSIS	53
2.3.5.1	MARKET SIZE	53
2.3.5.2	ENZYME APPLICATIONS	54
2.3.5.3	FUTURE TRENDS.....	54

Enzymes for the Food/Drink & Animal Feed Industries
2015-2020

Page 2

Multiclient Report

Section: Introduction

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2.4.	ENZYME USE IN ANIMAL FEED	54
2.4.1.1	MARKET SIZE	54
2.4.1.2	ENZYME APPLICATIONS	55
2.4.1.3	FUTURE TRENDS	55
3.	ENZYMES	56
3.1.	DEFINITION	56
3.1.1.	ENZYME ACTIVITY	57
3.2.	NAMING CONVENTIONS	58
3.3.	INDUSTRIAL ENZYMES: PRODUCTION AND APPLICATION	59
3.3.1.	SUBMERGED FERMENTATION	60
3.3.2.	SOLID STATE FERMENTATION (SSF)	61
3.4.	ENZYME IMMOBILIZATION	65
3.5.	PRODUCTION MICROORGANISMS	66
3.6.	ENZYMES IN FOOD PROCESSING	67
3.6.1.	BAKERY	68
3.6.1.1	REDUCTION OF ACRYLAMIDE CONTENT IN FOOD PRODUCTS	70
3.6.2.	FRUIT AND VEGETABLE PROCESSING	70
3.6.2.1	FRUIT JUICE PROCESSING	70
3.6.2.2	CITRUS FRUIT	71
3.6.3.	DAIRY	71
3.6.3.1	CHEESE MAKING	72
3.6.3.2	INFANT MILK FORMULA	73
3.6.4.	BREWING	73
3.6.5.	WINE	75
3.6.6.	DISTILLING	76
3.6.7.	ANIMAL FEED	76
3.6.7.1	NSP-DEGRADING ENZYMES	78
3.6.7.2	PET FOOD	78
3.6.8.	PROTEIN HYDROLYSIS FOR FOOD PROCESSING	78
3.6.8.1	FLAVOR ENHANCERS	79
3.6.9.	MEAT EXTRACTS	80
4.	USA	84
4.1.	INTRODUCTION	84
4.1.1.	DEMOGRAPHICS	84
4.2.	LEGISLATION	84
4.2.1.	INTRODUCTION	84
4.2.2.	BACKGROUND	85
4.2.3.	ROUTES TO APPROVAL	85
4.2.4.	PETITIONS FOR ENZYME PREPARATIONS	86
4.2.4.1	GRAS NOTICES FOR ENZYME PREPARATIONS	86
4.2.5.	RECOMMENDATIONS FOR PETITION & GRAS NOTICE PREPARATION	87
4.2.5.1	IDENTITY	87
4.2.5.2	MANUFACTURING PROCESS	89
4.2.5.3	SPECIFICATIONS FOR IDENTITY & PURITY	90

Enzymes for the Food/Drink & Animal Feed Industries
2015-2020
Multiclient Report

Page 3

Section: Introduction

© GIRACT

4.2.5.4	INTENDED TECHNICAL EFFECTS & USE	90
4.2.5.5	INTAKE ESTIMATE	91
4.2.6.	ADDITIONAL INFORMATION	91
4.2.6.1	ENZYME PREPARATIONS USED IN MEAT, POULTRY, & EGG PRODUCTS	91
4.2.6.2	ENZYME PREPARATIONS CONTAINING ALLERGENIC INGREDIENTS	92
4.3.	ENZYME SUPPLY	93
4.3.1.	PRODUCTION	93
4.3.2.	MAJOR PRODUCERS/SUPPLIERS	93
4.3.2.1	AB ENZYMES	93
4.3.2.2	AMANO ENZYME USA CO LTD	94
4.3.2.3	BASF	95
4.3.2.4	CHR HANSEN	96
4.3.2.5	CREATIVE ENZYMES	96
4.3.2.6	DSM	98
4.3.2.7	DUPONT	99
4.3.2.8	DYADIC INTERNATIONAL	100
4.3.2.9	ENZYME DEVELOPMENT CORPORATION	101
4.3.2.10	NOVOZYMES	102
4.3.2.11	SPECIALTY ENZYMES AND BIOTECHNOLOGIES	104
4.3.3.	OTHER PRODUCERS	106
4.4.	END-USE MARKET STRUCTURE	108
4.5.	BAKERY/CEREALS	108
4.5.1.	MILLING	108
4.5.2.	BAKING	109
4.5.2.1	FLOUR USE BY BAKERY PRODUCT/SECTOR	111
4.5.3.	NOODLES	112
4.5.4.	ENZYME USE IN BAKERY/CEREALS	112
4.5.4.1	TYPES & ORIGIN	113
4.5.4.2	ENZYME MARKET	114
4.5.4.3	AMYLASE	115
4.5.4.4	MALTOGENIC AMYLASE	116
4.5.4.5	GLUCOSE OXIDASE	116
4.5.4.6	LIPASE	117
4.5.4.7	OTHER	118
4.5.5.	ENZYME PRODUCERS - BAKERY/CEREALS	120
4.5.5.1	ENZYME BRANDS AND INCLUSION RATES	121
4.5.6.	ENZYME PRICES - BAKERY/CEREALS	121
4.5.7.	CURRENT & FORECAST DEMAND - BAKERY/CEREALS	122
4.5.8.	FUTURE DEVELOPMENTS - BAKERY/CEREALS	122
4.6.	BREWING, WINE & DISTILLED ALCOHOLIC DRINKS	123
4.6.1.	BREWING	123
4.6.2.	ENZYME USE IN BREWING	124
4.6.2.1	TYPES & ORIGIN	124
4.6.2.2	ENZYME MARKET	125
4.6.2.3	AMYLASE	126
4.6.2.4	GLUCOAMYLASE	127
4.6.2.5	BETA-GLUCANASE	128

Enzymes for the Food/Drink & Animal Feed Industries
2015-2020
[Multiclient Report](#)

Page 4

Section: Introduction

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4.6.2.6	XYLANASE.....	129
4.6.2.7	ALPHA-ACETOLACTATE DECARBOXYLASE.....	129
4.6.2.8	OTHER.....	130
4.6.3.	ENZYME PRODUCERS – BREWING.....	132
4.6.3.1	ENZYME BRANDS AND INCLUSION RATES.....	133
4.6.4.	ENZYME PRICES – BREWING.....	133
4.6.5.	CURRENT & FORECAST DEMAND – BREWING.....	133
4.6.6.	WINE.....	134
4.6.7.	ENZYME USE IN WINE.....	135
4.6.7.1	TYPES & ORIGIN.....	135
4.6.7.2	ENZYME MARKET.....	136
4.6.7.3	PECTINASE.....	136
4.6.7.4	BETA-GLUCANASE.....	137
4.6.7.5	HEMICELLULOSE.....	138
4.6.7.6	OTHER.....	138
4.6.8.	ENZYME PRODUCERS – WINE.....	140
4.6.8.1	ENZYME BRANDS AND INCLUSION RATES.....	141
4.6.9.	ENZYME PRICES – WINE.....	141
4.6.10.	CURRENT & FORECAST DEMAND – WINE.....	142
4.6.11.	DISTILLED ALCOHOLIC DRINKS.....	142
4.6.12.	ENZYME USE IN DISTILLED ALCOHOLIC DRINKS.....	143
4.6.12.1	TYPES & ORIGIN.....	144
4.6.12.2	ENZYME MARKET.....	144
4.6.12.3	ALPHA-AMYLASE.....	145
4.6.12.4	CELLULOSE.....	146
4.6.12.5	XYLANASE.....	146
4.6.12.6	BETAGLUCANASE.....	147
4.6.12.7	OTHER.....	148
4.6.13.	ENZYME PRODUCERS – DISTILLED ALCOHOLIC DRINKS.....	149
4.6.13.1	ENZYME BRANDS AND INCLUSION RATES.....	149
4.6.14.	ENZYME PRICES – DISTILLED ALCOHOLIC DRINKS.....	149
4.6.15.	CURRENT & FORECAST DEMAND – DISTILLED ALCOHOLIC DRINKS.....	150
4.7.	FRUIT PROCESSING.....	150
4.7.1.	APPLE JUICE.....	150
4.7.2.	ENZYME USE IN APPLE JUICE.....	151
4.7.2.1	TYPES & ORIGIN.....	151
4.7.2.2	ENZYME MARKET.....	151
4.7.2.3	PECTINASE.....	152
4.7.2.4	HEMICELLULOSE.....	153
4.7.2.5	OTHER.....	153
4.7.3.	CITRUS JUICE.....	154
4.7.4.	ENZYME USE IN CITRUS JUICE.....	155
4.7.4.1	TYPES & ORIGIN.....	155
4.7.4.2	ENZYME MARKET.....	155
4.7.4.3	PECTINASE.....	156
4.7.4.4	HEMICELLULOSE.....	157
4.7.4.5	OTHER.....	157
4.7.5.	OTHER FRUIT JUICES.....	157

Section: Introduction

© GIRACT

4.7.6.	ENZYME USE IN OTHER FRUIT JUICES.....	157
4.7.6.1	TYPES & ORIGIN.....	158
4.7.6.2	ENZYME MARKET.....	158
4.7.6.3	PECTINASE.....	158
4.7.6.4	HEMICELLULOSE.....	159
4.7.6.5	OTHER.....	160
4.7.7.	PREPARED FRUIT.....	161
4.7.8.	ENZYME USE IN PREPARED FRUIT.....	161
4.7.8.1	TYPES & ORIGIN.....	162
4.7.8.2	ENZYME MARKET.....	162
4.7.8.3	PECTINASE.....	162
4.7.8.4	PECTIN METHYLESTERASE.....	163
4.7.9.	ENZYME PRODUCERS – PREPARED FRUIT.....	163
4.7.9.1	ENZYME BRANDS AND INCLUSION RATES.....	163
4.7.10.	ENZYME PRICES – PREPARED FRUIT.....	164
4.7.11.	CURRENT & FORECAST DEMAND – PREPARED FRUIT.....	164
4.8.	DAIRY.....	164
4.8.1.	CHEESE.....	164
4.8.2.	ENZYME USE IN CHEESE.....	165
4.8.2.1	TYPES & ORIGIN.....	165
4.8.2.2	ENZYME MARKET.....	166
4.8.2.3	CHYMOSIN.....	166
4.8.2.4	PROTEASE.....	167
4.8.2.5	LIPASE.....	168
4.8.2.6	OTHER.....	169
4.8.3.	YOGURT.....	170
4.8.3.1	YOGURT PRODUCTION.....	170
4.8.4.	ENZYME USE IN YOGURT.....	171
4.8.4.1	TYPES & ORIGIN.....	171
4.8.4.2	ENZYME MARKET.....	171
4.8.4.3	TRANSGLUTAMINASE.....	171
4.8.5.	LACTOSE-FREE DAIRY PRODUCTS.....	172
4.8.6.	ENZYME USE IN LACTOSE-FREE DAIRY PRODUCTS.....	172
4.8.6.1	ENZYME MARKET.....	172
4.8.6.2	LACTASE.....	173
4.8.7.	ENZYME PRODUCERS – DAIRY.....	173
4.8.7.1	ENZYME BRANDS AND INCLUSION RATES.....	174
4.8.8.	ENZYME PRICES – DAIRY.....	174
4.8.9.	CURRENT & FORECAST DEMAND – DAIRY.....	174
4.8.10.	FUTURE DEVELOPMENTS – DAIRY.....	175
4.9.	PROTEIN HYDROLYSIS.....	175
4.9.1.	HYDROLYSED VEGETABLE/ANIMAL PROTEINS.....	175
4.9.1.1	HAP/HVP PRODUCTION.....	175
4.9.2.	HYDROLYSED COLLAGEN.....	175
4.9.3.	PLANT PROTEIN HYDROLYSATE PRODUCTION.....	176
4.9.4.	HYDROLYSED WHEY PROTEINS.....	176
4.9.5.	FISH SAUCE.....	176

Section: Introduction

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4.9.6.	NUCLEOTIDES	176
4.9.7.	ENZYME USE IN PROTEIN HYDROLYSIS	177
4.9.7.1	TYPES & ORIGIN	177
4.9.7.2	ENZYME MARKET	177
4.9.7.3	OTHER	177
4.9.7.4	PROTEASE	178
4.9.8.	ENZYME PRODUCERS – PROTEIN HYDROLYSIS	179
4.9.8.1	ENZYME BRANDS AND INCLUSION RATES	179
4.9.9.	ENZYME PRICES – PROTEIN HYDROLYSIS	179
4.9.10.	CURRENT & FORECAST DEMAND – PROTEIN HYDROLYSIS	180
4.10.	ANIMAL FEED	180
4.10.1.	PIGLET & CALF MILK REPLACERS	180
4.10.2.	ENZYME USE IN MILK REPLACERS	181
4.10.2.1	TYPES & ORIGIN	181
4.10.2.2	ENZYME MARKET	181
4.10.2.3	PROTEASE	181
4.10.2.4	LIPASE	182
4.10.3.	COMPOUND FEED	182
4.10.4.	ENZYME USE IN COMPOUND FEED	182
4.10.4.1	TYPES & ORIGIN	183
4.10.4.2	ENZYME MARKET	183
4.10.4.3	PHYTASE	184
4.10.4.4	AMYLASE	185
4.10.4.5	XYLANASE	186
4.10.4.6	PROTEASE	187
4.10.4.7	OTHER	187
4.10.5.	AQUACULTURE	188
4.10.6.	ENZYME USE IN AQUACULTURE	189
4.10.6.1	TYPES & ORIGIN	189
4.10.6.2	ENZYME MARKET	189
4.10.6.3	PROTEASE	190
4.10.6.4	CELLULASE	190
4.10.6.5	XYLANASE	190
4.10.6.6	OTHERS	191
4.10.7.	ENZYME PRODUCERS – FEED	191
4.10.7.1	ENZYME BRANDS AND INCLUSION RATES	191
4.10.8.	ENZYME PRICES – FEED	191
4.10.9.	CURRENT & FORECAST DEMAND – FEED	192
5.	EU28/NORWAY/SWITZERLAND	193
5.1.	INTRODUCTION	193
5.1.1.	DEMOGRAPHICS	193
5.2.	LEGISLATION	195
5.3.	ENZYME SUPPLY	214
5.3.1.	PRODUCTION	214
5.3.2.	MAJOR PRODUCERS/SUPPLIERS	215
5.3.2.1	ABF INGREDIENTS	215

Section: Introduction

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5.3.2.2	ADISSEO	217
5.3.2.3	BASF	218
5.3.2.4	BELDEM	219
5.3.2.5	BIOCATALYSTS	220
5.3.2.6	BSC BIOCHEMICALS/ENZYBEL	221
5.3.2.7	CHR HANSEN	221
5.3.2.8	DUPONT	222
5.3.2.9	ERBSLOH GEISENHEIM	223
5.3.2.10	KERRY GROUP	224
5.3.2.11	LYVEN	225
5.3.2.12	NOVOZYMES	226
5.3.2.13	DSM	229
5.3.3.	OTHER PRODUCERS	231
5.4.	END-USE MARKET STRUCTURE	238
5.5.	BAKERY/CEREALS	240
5.5.1.	MILLING	240
5.5.2.	BAKING	241
5.5.2.1	FLOUR USE BY BAKERY PRODUCT/SECTOR	243
5.5.3.	NOODLES	245
5.5.4.	ENZYME USE IN BAKERY/CEREALS	251
5.5.4.1	TYPES & ORIGIN	252
5.5.4.2	ENZYME MARKET	252
5.5.4.3	AMYLASE	253
5.5.4.4	MALTOGENIC AMYLASE	254
5.5.4.5	GLUCOSE OXIDASE	254
5.5.4.6	LIPASE	255
5.5.4.7	OTHER	256
5.5.5.	ENZYME PRODUCERS – BAKERY/CEREALS	258
5.5.5.1	ENZYME BRANDS AND INCLUSION RATES	259
5.5.6.	ENZYME PRICES – BAKERY/CEREALS	260
5.5.7.	CURRENT & FORECAST DEMAND – BAKERY/CEREALS	260
5.5.8.	FUTURE DEVELOPMENTS – BAKERY/CEREALS	261
5.6.	BREWING, WINE & DISTILLED ALCOHOLIC DRINKS	261
5.6.1.	BREWING	261
5.6.2.	ENZYME USE IN BREWING	265
5.6.2.1	TYPES & ORIGIN	265
5.6.2.2	ENZYME MARKET	266
5.6.2.3	AMYLASE	267
5.6.2.4	GLUCOAMYLASE	268
5.6.2.5	BETA-GLUCANASE	269
5.6.2.6	XYLANASE	270
5.6.2.7	ALPHA-ACETOLACTATE DECARBOXYLASE	271
5.6.2.8	OTHER	272
5.6.3.	ENZYME PRODUCERS – BREWING	273
5.6.3.1	ENZYME BRANDS AND INCLUSION RATES	274
5.6.4.	ENZYME PRICES – BREWING	275
5.6.5.	CURRENT & FORECAST DEMAND – BREWING	275

Section: Introduction

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5.6.6.	FUTURE DEVELOPMENTS – BREWING	276
5.6.7.	WINE.....	276
5.6.8.	ENZYME USE IN WINE.....	280
5.6.8.1	TYPES & ORIGIN	280
5.6.8.2	ENZYME MARKET	280
5.6.8.3	PECTINASE.....	281
5.6.8.4	HEMICELLULOSE.....	283
5.6.8.5	OTHER.....	283
5.6.9.	ENZYME PRODUCERS – WINE	284
5.6.9.1	ENZYME BRANDS AND INCLUSION RATES.....	284
5.6.10.	ENZYME PRICES – WINE.....	285
5.6.11.	CURRENT & FORECAST DEMAND – WINE	285
5.6.12.	FUTURE DEVELOPMENTS – WINE	285
5.6.13.	DISTILLED ALCOHOLIC DRINKS.....	286
5.6.14.	ENZYME USE IN ALCOHOLIC DRINKS	287
5.6.14.1	TYPES & ORIGIN	288
5.6.14.2	ENZYME MARKET	288
5.6.14.3	ALPHA-AMYLASE	289
5.6.14.4	CELLULOSE.....	289
5.6.14.5	XYLANASE.....	290
5.6.14.6	BETAGLUCANASE.....	290
5.6.14.7	OTHER.....	291
5.6.15.	ENZYME PRODUCERS – DISTILLED ALCOHOLIC DRINKS	292
5.6.15.1	ENZYME BRANDS AND INCLUSION RATES.....	292
5.6.16.	ENZYME PRICES – DISTILLED ALCOHOLIC DRINKS	293
5.6.17.	CURRENT & FORECAST DEMAND – DISTILLED ALCOHOLIC DRINKS.....	293
5.6.18.	FUTURE DEVELOPMENTS – DISTILLED ALCOHOLIC DRINKS	294
5.7.	FRUIT PROCESSING	294
5.7.1.	APPLE JUICE.....	299
5.7.2.	ENZYME USE IN APPLE JUICE	300
5.7.2.1	TYPES & ORIGIN	301
5.7.2.2	ENZYME MARKET	301
5.7.2.3	PECTINASE.....	302
5.7.2.4	HEMICELLULOSE.....	304
5.7.2.5	OTHER.....	304
5.7.3.	CITRUS JUICES.....	305
5.7.4.	ENZYME USE IN CITRUS JUICE.....	306
5.7.4.1	TYPES & ORIGIN	306
5.7.4.2	ENZYME MARKET	306
5.7.4.3	PECTINASE.....	307
5.7.4.4	HEMICELLULOSE.....	308
5.7.4.5	OTHER.....	309
5.7.5.	OTHER FRUIT JUICES.....	309
5.7.6.	ENZYME USE IN OTHER JUICE	310
5.7.6.1	TYPES & ORIGIN	311
5.7.6.2	ENZYME MARKET	311
5.7.6.3	PECTINASE.....	312
5.7.6.4	HEMICELLULOSE.....	316

Section: Introduction

© GIRACT

5.7.6.5	OTHER.....	316
5.7.7.	PREPARED FRUIT	317
5.7.8.	ENZYME USE IN PREPARED FRUIT	318
5.7.8.1	TYPES & ORIGIN	319
5.7.8.2	ENZYME MARKET	319
5.7.8.3	PECTINASE.....	320
5.7.8.4	HEMICELLULOSE.....	322
5.7.8.5	OTHER.....	322
5.7.9.	ENZYME PRODUCERS – PREPARED FRUIT	322
5.7.9.1	ENZYME BRANDS AND INCLUSION RATES.....	323
5.7.10.	ENZYME PRICES – PREPARED FRUIT	324
5.7.11.	CURRENT DEMAND & FORECAST – PREPARED FRUIT.....	324
5.7.12.	FUTURE DEVELOPMENTS – PREPARED FRUIT	325
5.8.	DAIRY.....	325
5.8.1.	CHEESE.....	326
5.8.2.	ENZYME USE IN CHEESE.....	327
5.8.2.1	TYPES & ORIGIN	327
5.8.2.2	ENZYME MARKET	328
5.8.2.3	CHYMOSIN.....	328
5.8.2.4	PROTEASE.....	329
5.8.2.5	LIPASE.....	329
5.8.2.6	PHOSPHOLIPASE.....	329
5.8.2.7	OTHER.....	330
5.8.3.	YOGURT	330
5.8.4.	ENZYME USE IN YOGURT.....	332
5.8.4.1	TYPES & ORIGIN	332
5.8.4.2	ENZYME MARKET	333
5.8.4.3	TRANSGLUTAMINASE	333
5.8.5.	LACTOSE-FREE DAIRY PRODUCTS.....	333
5.8.6.	ENZYME USE IN LACTOSE-FREE DAIRY	335
5.8.6.1	LACTASE.....	335
5.8.6.2	ENZYME MARKET	336
5.8.7.	ENZYME PRODUCERS – DAIRY.....	336
5.8.7.1	ENZYME BRANDS AND INCLUSION RATES.....	337
5.8.8.	ENZYME PRICES – DAIRY.....	337
5.8.9.	CURRENT DEMAND & FORECAST – DAIRY	338
5.8.10.	FUTURE DEVELOPMENTS – DAIRY.....	338
5.9.	PROTEIN HYDROLYSIS.....	339
5.9.1.	HYDROLYSED VEGETABLE/ANIMAL PROTEINS.....	339
5.9.1.1	HVP.....	339
5.9.1.2	HAP.....	340
5.9.2.	HYDROLYSED COLLAGEN.....	341
5.9.3.	PLANT PROTEIN HYDROLYSATE	342
5.9.4.	HYDROLYSED WHEY PROTEIN	343
5.9.5.	FISH SAUCE.....	344
5.9.6.	NUCLEOTIDES	345
5.9.7.	ENZYME USE IN PROTEIN HYDROLYSIS	345

Section: Introduction

© GIRACT

5.9.7.1	TYPES & ORIGIN	345
5.9.7.2	ENZYME MARKET	345
5.9.7.3	PROTEASE	346
5.9.7.4	OTHER	347
5.9.8	ENZYME PRODUCERS – PROTEIN HYDROLYSIS	347
5.9.8.1	ENZYME BRANDS AND INCLUSION RATES	348
5.9.9	ENZYME PRICES – PROTEIN HYDROLYSIS	348
5.9.10	CURRENT & FORECAST DEMAND – PROTEIN HYDROLYSIS	348
5.9.11	FUTURE DEVELOPMENTS – PROTEIN HYDROLYSIS	349
5.10	ANIMAL FEED	349
5.10.1	PIGLET & CALF MILK REPLACERS	352
5.10.2	ENZYME USE IN PIGLET AND CALF MILK REPLACERS	355
5.10.2.1	TYPES & ORIGIN	356
5.10.2.2	ENZYME MARKET	356
5.10.2.3	PROTEASE	357
5.10.2.4	LIPASE	357
5.10.3	COMPOUND FEED	357
5.10.4	ENZYME USE IN COMPOUND FEED	359
5.10.4.1	TYPES & ORIGIN	360
5.10.4.2	ENZYME MARKET	360
5.10.4.3	PHYTASE	361
5.10.4.4	AMYLASE	362
5.10.4.5	CELLULOSE	362
5.10.4.6	MANNAANASE	363
5.10.4.7	PROTEASE	363
5.10.4.8	OTHER	363
5.10.5	AQUACULTURE	365
5.10.6	ENZYME USE IN AQUACULTURE	368
5.10.6.1	TYPES & ORIGIN	369
5.10.6.2	ENZYME MARKET	369
5.10.6.3	ENZYME BRANDS AND INCLUSION RATES	370
5.10.6.4	PROTEASE	370
5.10.6.5	CELLULOSE	371
5.10.6.6	XYLANASE	371
5.10.6.7	OTHER	371
5.10.7	ENZYME PRODUCERS – ANIMAL FEED	372
5.10.8	ENZYME PRICES – ANIMAL FEED	372
5.10.9	CURRENT & FORECAST DEMAND – ANIMAL FEED	373
5.10.10	FUTURE DEVELOPMENTS – ANIMAL FEED	373
5.11	END–USER PERCEPTIONS	374
5.11.1	AGRANA GROUP	380
5.11.2	ARLA FOODS UK	382
5.11.3	BRENNAN’S BAKERY	384
5.11.4	GELITA	386
5.11.5	GUENTHER BAKERIES UK	387
5.11.6	HAMLET PROTEIN	389
5.11.7	HARBOES BREWERY	390

Section: Introduction

© GIRACT

5.11.8	INNOCENT DRINKS	392
5.11.9	KELLS WHOLEMEAL	392
5.11.10	LACTALIS	394
5.11.11	SPF–DIANA	395
5.11.12	SPL INTERNATIONAL	397
5.11.13	STAPLETON’S BAKERY	399
5.11.14	WATERGULL ORCHARDS UK	400
5.11.15	WENSLEYDALE CREAMERY	401
6	CHINA	403
6.1	INTRODUCTION	403
6.1.1	DEMOGRAPHICS	403
6.2	LEGISLATION	403
6.3	ENZYME SUPPLY	409
6.3.1	PRODUCTION	409
6.3.2	MAJOR PRODUCERS/SUPPLIERS	410
6.3.2.1	BEIJING CHALLENGE BIO–TECHNOLOGY COMPANY	410
6.3.2.2	DANISCO CHINA/ WUXI GENENCOR (DUPONT) CHINA BIO–PRODUCTS	411
6.3.2.3	DONGGUAN HUAQI BIOLOGICAL SCIENCE AND TECHNOLOGY	412
6.3.2.4	DSM JIANGSU BIOTECHNOLOGY	413
6.3.2.5	GUANGDONG VTR BIO–TECH	413
6.3.2.6	GUANGXI NANNING PANGBO BIOLOGICAL ENGINEERING	414
6.3.2.7	HENAN YANGSHAO BIO–PRODUCTS	416
6.3.2.8	NANNING DOING–HIGHER BIO–TECH	417
6.3.2.9	LEYEKING BIO–ENGINEERING	418
6.3.2.10	NINGXIA XIASHENG IND. GROUP	419
6.3.2.11	NOVOZYMES CHINA	420
6.3.2.12	SHANDONG LONGDA BIO–PRODUCTS (FORMER YISHUI ENZYME FACTORY)	421
6.3.2.13	SHANDONG SUKAHAN BIO–TECHNOLOGY CO., LTD.	422
6.3.2.14	V.PARD BIOTECHNOLOGY/ SUZHOU WEIBANG BIOTECHNOLOGY	424
6.3.2.15	WUHAN SUNHY BIOLOGY	424
6.3.2.16	OTHERS	426
6.4	END–USE MARKET STRUCTURE	431
6.5	BAKERY/CEREALS/NOODLES	431
6.5.1	MILLING	431
6.5.2	BAKING	432
6.5.2.1	FLOUR USE BY BAKERY PRODUCT/SECTOR	434
6.5.3	NOODLES	434
6.5.4	ENZYME USE IN BAKERY/CEREALS/NOODLES	435
6.5.4.1	TYPES & ORIGIN	436
6.5.4.2	ENZYME MARKET	437
6.5.4.3	AMYLASE	437
6.5.4.4	MALTOGENIC AMYLASE	438
6.5.4.5	GLUCOSE OXIDASE	438
6.5.4.6	LIPASE	438
6.5.4.7	OTHER	439
6.5.5	ENZYME PRODUCERS – BAKERY/CEREALS/NOODLES	440

Section: Introduction

© GIRACT

6.5.5.1	ENZYME BRANDS AND INCLUSION RATES.....	441
6.5.6.	ENZYME PRICES – BAKERY/CEREALS/NOODLES.....	441
6.5.7.	CURRENT & FORECAST DEMAND – BAKERY/CEREALS/NOODLES.....	442
6.5.8.	FUTURE DEVELOPMENTS – BAKERY/CEREALS/NOODLES.....	443
6.6.	BREWING, WINE & DISTILLED ALCOHOLIC DRINKS.....	443
6.6.1.	BREWING.....	443
6.6.2.	ENZYME USE IN BREWING.....	444
6.6.2.1	TYPES & ORIGIN.....	444
6.6.2.2	ENZYME MARKET.....	445
6.6.2.3	AMYLASE.....	446
6.6.2.4	GLUCOAMYLASE.....	446
6.6.2.5	BETA-GLUCANASE.....	447
6.6.2.6	XYLANASE.....	447
6.6.2.7	ALPHA-ACETOLACTATE DECARBOXYLASE.....	448
6.6.2.8	OTHER.....	448
6.6.3.	ENZYME PRODUCERS – BREWING.....	449
6.6.3.1	ENZYME BRANDS AND INCLUSION RATES.....	449
6.6.4.	ENZYME PRICES – BREWING.....	450
6.6.5.	CURRENT & FORECAST DEMAND – BREWING.....	450
6.6.6.	FUTURE DEVELOPMENTS – BREWING.....	451
6.6.7.	WINE.....	451
6.6.8.	ENZYMES USE IN WINE MAKING.....	451
6.6.8.1	TYPES & ORIGIN.....	452
6.6.8.2	ENZYME MARKET.....	452
6.6.8.3	PECTINASE.....	453
6.6.8.4	CELLULOSE.....	453
6.6.8.5	HEMICELLULOSE.....	453
6.6.8.6	OTHER.....	454
6.6.9.	ENZYME PRODUCERS – WINE.....	454
6.6.9.1	ENZYME BRANDS AND INCLUSION RATES.....	455
6.6.10.	ENZYME PRICES – WINE.....	455
6.6.11.	CURRENT & FORECAST DEMAND – WINE.....	456
6.6.12.	FUTURE DEVELOPMENTS – WINE.....	456
6.6.13.	DISTILLED ALCOHOLIC DRINKS.....	456
6.6.14.	VINEGAR.....	457
6.6.15.	ENZYME USE IN DISTILLED ALCOHOLIC DRINKS/VINEGAR.....	458
6.6.15.1	TYPES & ORIGIN.....	459
6.6.15.2	ENZYME MARKET.....	459
6.6.15.3	ALPHA-AMYLASE.....	460
6.6.15.4	CELLULOSE.....	460
6.6.15.5	XYLANASE.....	460
6.6.15.6	BETAGLUCANASE.....	461
6.6.15.7	OTHER.....	461
6.6.16.	ENZYME PRODUCERS – DISTILLED ALCOHOLIC DRINKS/VINEGAR.....	462
6.6.16.1	ENZYME BRANDS AND INCLUSION RATES.....	462
6.6.17.	ENZYME PRICES – DISTILLED ALCOHOLIC DRINKS/VINEGAR.....	462
6.6.18.	CURRENT & FORECAST DEMAND – DISTILLED ALCOHOLIC DRINKS/VINEGAR.....	463
6.6.19.	FUTURE DEVELOPMENTS – DISTILLED ALCOHOLIC DRINKS/VINEGAR.....	463

Section: Introduction

© GIRACT

6.7.	FRUIT PROCESSING.....	464
6.7.1.	APPLE JUICE.....	465
6.7.1.1	APPLE JUICE PRODUCTION.....	465
6.7.2.	ENZYME USE IN APPLE JUICE.....	466
6.7.2.1	TYPES & ORIGIN.....	466
6.7.2.2	ENZYME MARKET.....	466
6.7.2.3	PECTINASE.....	467
6.7.2.4	HEMICELLULOSE.....	467
6.7.2.5	OTHER.....	468
6.7.3.	CITRUS JUICE.....	468
6.7.4.	ENZYME USE IN CITRUS JUICE.....	469
6.7.4.1	TYPES & ORIGIN.....	469
6.7.4.2	ENZYME MARKET.....	470
6.7.4.3	PECTINASE.....	470
6.7.4.4	HEMICELLULOSE.....	471
6.7.4.5	OTHER.....	471
6.7.5.	OTHER FRUIT JUICES.....	471
6.7.6.	ENZYME USE IN OTHER JUICE.....	472
6.7.6.1	TYPES & ORIGIN.....	472
6.7.6.2	ENZYME MARKET.....	473
6.7.6.3	PECTINASE.....	473
6.7.6.4	HEMICELLULOSE.....	473
6.7.6.5	OTHER.....	474
6.7.7.	PREPARED FRUIT.....	474
6.7.8.	ENZYME USE IN PREPARED FRUIT.....	475
6.7.8.1	TYPES & ORIGIN.....	475
6.7.8.2	ENZYME MARKET.....	475
6.7.8.3	PECTINASE.....	476
6.7.8.4	HEMICELLULOSE.....	476
6.7.8.5	OTHER.....	476
6.7.9.	ENZYME PRODUCERS – PREPARED FRUIT.....	477
6.7.9.1	ENZYME BRANDS AND INCLUSION RATES.....	477
6.7.10.	ENZYME PRICES – PREPARED FRUIT.....	478
6.7.11.	CURRENT & FORECAST DEMAND – PREPARED FRUIT.....	478
6.7.12.	FUTURE DEVELOPMENTS – PREPARED FRUIT.....	479
6.8.	DAIRY.....	479
6.8.1.	CHEESE.....	479
6.8.2.	ENZYME USE IN CHEESE.....	480
6.8.2.1	TYPES & ORIGIN.....	480
6.8.2.2	ENZYME MARKET.....	480
6.8.2.3	CHYMOSIN.....	481
6.8.2.4	PROTEASE.....	481
6.8.2.5	LIPASE.....	482
6.8.2.6	PHOSPHOLIPASE.....	482
6.8.2.7	OTHER.....	482
6.8.3.	YOGURT.....	482
6.8.4.	ENZYME USE IN YOGURT.....	483
6.8.4.1	TYPES & ORIGIN.....	483

Section: Introduction

© GIRACT

6.8.4.2	ENZYME MARKET	483
6.8.4.3	TRANSGLUTAMINASE	484
6.8.4.4	OTHER	484
6.8.5.	LACTOSE-FREE DAIRY PRODUCTS	484
6.8.5.1	LACTOSE FREE DAIRY PRODUCTION	485
6.8.6.	ENZYME USE IN LACTOSE-FREE DAIRY	486
6.8.6.1	ENZYME MARKET	486
6.8.6.2	LACTASE	486
6.8.7.	ENZYME PRODUCERS – LACTOSE-FREE DAIRY	486
6.8.7.1	ENZYME BRANDS AND INCLUSION RATES	487
6.8.8.	ENZYME PRICES – LACTOSE-FREE DAIRY	487
6.8.9.	CURRENT & FORECAST DEMAND – LACTOSE-FREE DAIRY	488
6.8.10.	FUTURE DEVELOPMENTS – LACTOSE-FREE DAIRY	488
6.9.	PROTEIN HYDROLYSIS	489
6.9.1.	HYDROLYSED VEGETABLE/ANIMAL PROTEINS	489
6.9.1.1	HVP	489
6.9.1.2	HAP	489
6.9.1.3	HYDROLYSED COLLAGEN	490
6.9.1.4	PLANT PROTEIN HYDROLYSATE PRODUCTION	491
6.9.1.5	HYDROLYSED WHEY PROTEINS	491
6.9.1.6	FISH AND SOY SAUCE	492
6.9.1.7	MONOSODIUM GLUTAMATE AND NUCLEOTIDES	492
6.9.1.8	PROCESSED MEAT AND FISH	494
6.9.2.	ENZYME USE IN PROTEIN HYDROLYSIS	495
6.9.2.1	TYPES & ORIGIN	496
6.9.2.2	ENZYME MARKET	496
6.9.2.3	PROTEASE	497
6.9.2.4	OTHER	498
6.9.3.	ENZYME PRODUCERS – PROTEIN HYDROLYSIS	499
6.9.3.1	ENZYME BRANDS AND INCLUSION RATES	499
6.9.4.	ENZYME PRICES – PROTEIN HYDROLYSIS	500
6.9.5.	CURRENT & FORECAST DEMAND – PROTEIN HYDROLYSIS	500
6.9.6.	FUTURE DEVELOPMENTS – PROTEIN HYDROLYSIS	500
6.10.	ANIMAL FEED	501
6.10.1.	PIGLET & CALF MILK REPLACERS	502
6.10.2.	ENZYMES – PIGLET & CALF MILK REPLACERS	503
6.10.2.1	TYPES & ORIGIN	504
6.10.2.2	ENZYME MARKET	504
6.10.2.3	PROTEASE	505
6.10.2.4	LIPASE	505
6.10.2.5	OTHER	506
6.10.3.	COMPOUND FEED	506
6.10.4.	ENZYME USE IN COMPOUND FEED	507
6.10.4.1	TYPES & ORIGIN	508
6.10.4.2	ENZYME MARKET	508
6.10.4.3	PHYTASE	509
6.10.4.4	AMYLASE	510

Section: Introduction

© GIRACT

6.10.4.5	CELLULASE	510
6.10.4.6	MANNANASE	510
6.10.4.7	PROTEASE	511
6.10.4.8	OTHER	511
6.10.5.	AQUACULTURE	513
6.10.6.	ENZYME USE IN ANIMAL FEED	514
6.10.6.1	TYPES & ORIGIN	515
6.10.6.2	ENZYME MARKET	515
6.10.6.3	PROTEASE	516
6.10.6.4	CELLULASE	516
6.10.6.5	XYLANASE	517
6.10.6.6	OTHER	517
6.10.7.	ENZYME PRODUCERS – ANIMAL FEED	518
6.10.7.1	ENZYME BRANDS AND INCLUSION RATES	518
6.10.8.	ENZYME PRICES – ANIMAL FEED	520
6.10.9.	CURRENT & FORECAST DEMAND – ANIMAL FEED	520
6.10.10.	FUTURE DEVELOPMENTS – ANIMAL FEED	521
6.11.	END-USER PERCEPTIONS	522
6.11.1.	BEIJING HUIYUAN GROUP	527
6.11.2.	BEIJING SDIC ZHONGLU FRUIT JUICE	528
6.11.3.	FUJIAN DALI GROUP	529
6.11.4.	FUJIAN JIN XING FEED COMPANY	531
6.11.5.	GUANGDONG BUDWEISER (FOSHAN) BEER	532
6.11.6.	GUANGZHOU ELITE EXTRACT	533
6.11.7.	GUANGZHOU PURATOS FOODS	534
6.11.8.	HENAN HUA MEI FEED COMPANY	536
6.11.9.	HUBEI ANGEL YEAST	538
6.11.10.	HUBEI JINBAILI BREWERY	540
6.11.11.	SHANDONG QISHUI FEED MILL	541
6.11.12.	SHANDONG BOHAI FEED PROTEIN	542
6.11.13.	SHANGHAI BRIGHT CHEESE & BUTTER	543
6.11.14.	SHANDONG CHANGYU	544
6.11.15.	YUNNAN ZHENG LIAN FEED COMPANY	545
6.11.16.	ZHEJIANG PANDA DAIRY	546
7.	INDIA	548
7.1.	INTRODUCTION	548
7.1.1.	DEMOGRAPHICS	548
7.2.	LEGISLATION	548
7.3.	ENZYME SUPPLY	549
7.3.1.	PRODUCTION	549
7.3.2.	TRADE	551
7.3.3.	MAJOR PRODUCERS/SUPPLIERS	551
7.3.3.1	NOVOZYMES SOUTH ASIA	551
7.3.3.2	ADVANCED ENZYMES	553
7.3.3.3	ROSSARI BIOTECH	555
7.3.3.4	MAPS ENZYME	555

Section: Introduction

© GIRACT

7.3.3.5	AUMGENE BIOSCIENCES.....	556
7.3.3.6	CHR HANSEN.....	558
7.3.3.7	DSM.....	559
7.3.3.8	LUMIS BIOTECH.....	559
7.3.3.9	ANIL BIOPUS.....	561
7.3.3.10	OTHER PRODUCERS.....	562
7.4.	END-USE MARKET STRUCTURE.....	562
7.5.	BAKERY/CEREALS.....	563
7.5.1.	MILLING.....	563
7.5.2.	BAKING.....	564
7.5.3.	NOODLES.....	566
7.5.4.	ENZYME USE IN BAKERY/CEREALS.....	567
7.5.4.1	TYPES & ORIGIN.....	567
7.5.4.2	ENZYME MARKET.....	568
7.5.4.3	AMYLASE.....	568
7.5.4.4	MALTOGENIC AMYLASE.....	568
7.5.4.5	GLUCOSE OXIDASE.....	569
7.5.4.6	LIPASE.....	569
7.5.4.7	OTHER.....	569
7.5.5.	ENZYME PRODUCERS – BAKERY/CEREALS.....	571
7.5.5.1	ENZYME BRANDS AND INCLUSION RATES.....	571
7.5.6.	ENZYME PRICES – BAKERY/CEREALS.....	571
7.5.7.	CURRENT & FORECAST DEMAND – BAKERY/CEREALS.....	572
7.5.8.	FUTURE DEVELOPMENTS – BAKERY/CEREALS.....	572
7.6.	BREWING, WINE & DISTILLED ALCOHOLIC DRINKS.....	572
7.6.1.	BREWING.....	572
7.6.2.	ENZYME USE IN BREWING.....	573
7.6.2.1	TYPES & ORIGIN.....	573
7.6.2.2	ENZYME MARKET.....	573
7.6.2.3	AMYLASE.....	574
7.6.2.4	GLUCOAMYLASE.....	574
7.6.2.5	BETA – GLUCANASE.....	575
7.6.2.6	ALPHA – ACETOLACTATE DECARBOXYLASE.....	575
7.6.2.7	OTHER.....	575
7.6.3.	ENZYME PRODUCERS – BREWING.....	577
7.6.3.1	ENZYME BRANDS AND INCLUSION RATES.....	577
7.6.4.	ENZYME PRICES – BREWING.....	577
7.6.5.	CURRENT & FORECAST DEMAND – BREWING.....	578
7.6.6.	FUTURE DEVELOPMENTS – BREWING.....	578
7.6.7.	WINE.....	578
7.6.8.	ENZYME USE IN WINE MAKING.....	579
7.6.8.1	TYPES & ORIGIN.....	579
7.6.8.2	ENZYME MARKET.....	579
7.6.8.3	PECTINASE.....	579
7.6.8.4	OTHER.....	580
7.6.9.	ENZYME PRODUCERS – WINE.....	580
7.6.9.1	ENZYME BRANDS AND INCLUSION RATES.....	580

Section: Introduction

© GIRACT

7.6.10.	ENZYME PRICES – WINE.....	580
7.6.11.	CURRENT & FORECAST DEMAND – WINE.....	581
7.6.12.	FUTURE DEVELOPMENTS – WINE.....	581
7.6.13.	DISTILLED ALCOHOLIC DRINKS.....	581
7.6.14.	ENZYME USE IN DISTILLED ALCOHOLIC DRINKS.....	581
7.6.14.1	TYPES & ORIGIN.....	582
7.6.14.2	ENZYME MARKET.....	582
7.6.14.3	ALPHA – AMYLASE.....	582
7.6.14.4	BETAGLUCANASE.....	583
7.6.14.5	OTHER.....	583
7.6.15.	ENZYME PRODUCERS – DISTILLED ALCOHOLIC DRINKS.....	584
7.6.15.1	ENZYME BRANDS AND INCLUSION RATES.....	584
7.6.16.	ENZYME PRICES – DISTILLED ALCOHOLIC DRINKS.....	584
7.6.17.	CURRENT & FORECAST DEMAND – DISTILLED ALCOHOLIC DRINKS.....	584
7.6.18.	FUTURE DEVELOPMENTS – DISTILLED ALCOHOLIC DRINKS.....	585
7.7.	FRUIT PROCESSING.....	585
7.7.1.	APPLE JUICE.....	585
7.7.2.	ENZYME USE IN APPLE JUICE.....	586
7.7.2.1	TYPES & ORIGIN.....	586
7.7.2.2	ENZYME MARKET.....	586
7.7.2.3	PECTINASE.....	586
7.7.2.4	OTHER.....	587
7.7.3.	CITRUS JUICE.....	587
7.7.4.	ENZYME USE IN CITRUS JUICE.....	587
7.7.4.1	TYPES & ORIGIN.....	587
7.7.4.2	ENZYME MARKET.....	588
7.7.4.3	PECTINASE.....	588
7.7.4.4	OTHER.....	588
7.7.5.	OTHER FRUIT JUICE.....	588
7.7.6.	ENZYME USE IN OTHER JUICE.....	589
7.7.6.1	TYPES & ORIGIN.....	589
7.7.6.2	ENZYME MARKET.....	589
7.7.6.3	PECTINASE.....	590
7.7.6.4	OTHER.....	590
7.7.7.	PREPARED FRUIT.....	591
7.7.8.	ENZYME PRODUCERS – PREPARED FRUIT.....	591
7.7.8.1	ENZYME BRANDS AND INCLUSION RATES.....	591
7.7.9.	ENZYME PRICES – PREPARED FRUIT.....	591
7.7.10.	CURRENT & FORECAST DEMAND – PREPARED FRUIT.....	592
7.7.11.	FUTURE DEVELOPMENTS – PREPARED FRUIT.....	592
7.8.	DAIRY.....	592
7.8.1.	CHEESE.....	592
7.8.2.	ENZYME USE IN CHEESE.....	593
7.8.2.1	TYPES & ORIGIN.....	594
7.8.2.2	ENZYME MARKET.....	594
7.8.2.3	CHYMOSIN.....	594
7.8.2.4	PROTEASE.....	595

Section: Introduction

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7.8.2.5	LIPASE	595
7.8.2.6	PHOSPHOLIPASE	595
7.8.2.7	OTHER	595
7.8.3.	YOGURT	596
7.8.4.	LACTOSE-FREE DAIRY PRODUCTS	596
7.8.5.	ENZYME PRODUCERS – DAIRY	597
7.8.5.1	ENZYME BRANDS AND INCLUSION RATES	597
7.8.6.	ENZYME PRICES – DAIRY	597
7.8.7.	CURRENT & FORECAST DEMAND – DAIRY	597
7.8.8.	FUTURE DEVELOPMENTS – DAIRY	597
7.9.	PROTEIN HYDROLYSIS	598
7.9.1.	HYDROLYSED VEGETABLE/ANIMAL PROTEINS	598
7.9.1.1	HYDROLYSED VEGETABLE PROTEIN	598
7.9.1.2	HYDROLYSED ANIMAL PROTEIN	598
7.9.1.3	HYDROLYSED COLLAGEN	598
7.9.1.4	PLANT PROTEIN HYDROLYSATES	599
7.9.1.5	HYDROLYSED WHEY PROTEIN	599
7.9.1.6	FISH SAUCE	599
7.9.1.7	NUCLEOTIDES	599
7.9.2.	ENZYME USE IN PROTEIN HYDROLYSIS	599
7.9.2.1	TYPES & ORIGIN	599
7.9.2.2	ENZYME MARKET	600
7.9.2.3	OTHER	601
7.9.3.	ENZYME PRODUCERS – PROTEIN HYDROLYSIS	601
7.9.3.1	ENZYME BRANDS AND INCLUSION RATES	601
7.9.4.	ENZYME PRICES – PROTEIN HYDROLYSIS	601
7.9.5.	CURRENT & FORECAST DEMAND – PROTEIN HYDROLYSIS	602
7.9.6.	FUTURE DEVELOPMENTS – PROTEIN HYDROLYSIS	602
7.10.	ANIMAL FEED	602
7.10.1.	PIGLET & CALF MILK REPLACERS	602
7.10.2.	COMPOUND FEED	602
7.10.3.	ENZYME USE IN FEED	603
7.10.3.1	TYPES & ORIGIN	603
7.10.3.2	ENZYME MARKET	603
7.10.3.3	PHYTASE	604
7.10.3.4	AMYLASE	604
7.10.3.5	MANNANASE	604
7.10.3.6	PROTEASE	605
7.10.3.7	OTHER	605
7.10.4.	AQUACULTURE	607
7.10.5.	ENZYME USE IN AQUACULTURE	607
7.10.5.1	TYPES & ORIGIN	607
7.10.5.2	ENZYME MARKET	607
7.10.6.	ENZYME PRODUCERS – ANIMAL FEED	608
7.10.6.1	ENZYME BRANDS AND INCLUSION RATES	608
7.10.7.	ENZYME PRICES – ANIMAL FEED	608
7.10.8.	CURRENT & FORECAST DEMAND – ANIMAL FEED	608

Section: Introduction

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7.10.9.	FUTURE DEVELOPMENTS – ANIMAL FEED	609
7.11.	END-USER PERCEPTIONS	609
7.11.1.	AMALGAM SPECIALITY FOODS	610
7.11.2.	A.M.BREWERIES	611
7.11.3.	BRITANNIA INDUSTRIES	612
7.11.4.	CHITALE DAIRY	613
7.11.5.	GREEN DAIRY FARM	614
7.11.6.	HP HORTICULTURAL PRODUCE MARKETING AND PROCESSING CORPORATION	615
7.11.7.	PRATHMESH WINES PVT LTD	616
7.11.8.	SCHREIBER DYNAMIX	617
7.11.9.	SUBONEYO CHEMICALS PHARMACEUTICALS (P) LIMITED	618
7.11.10.	VAIGHAI AGRO PRODUCTS	619

1. INTRODUCTION

1.1. BACKGROUND

Enzymes are biocatalysts. Over 2000 different kinds are known, each catalysing a different chemical reaction. Use of enzymes in food/drink and animal feed is growing due to their effectiveness and specificity of enzymes in promoting chemical reactions.

In the USA and in Europe bakery is currently an interesting markets for enzyme suppliers. Enzymes are considered "natural" and can be treated as "processing aids" (may change in Europe), so there is considerable interest in enzymes as a means to develop "clean label" baked-goods. However, persistent questions on genetic modification, particularly in Europe, have been a major stumbling block for many high-performance enzymes.

China has emerged as an extremely important market in view of its position as global leader in beer and apple juice concentrate production. Enzymes have been widely used in the Chinese beer industry for a long time and technological advances in China, adapting enzymes to various applications including traditional Chinese food have given an impetus to the market there.

India is a growing hub of food processing, and has seen rapid growth in all sectors including brewing and fruit processing. It is also emerging as a significant producer of enzymes with many biotechnology companies setting up their production facilities. Protein hydrolysis and modification represent a major opportunity for enzyme producers with growing demands for speciality enzymes.

Animal feed is a vast and growing market for enzymes.

Giract has been following the global enzymes market for many years. Its first study of the market in China was in 2001. It examined the global market for bakery enzymes market in 2007 and more recently in 2013. Confidential projects on enzyme markets globally have added to Giract's knowledge of these ingredients. The current study provides a comprehensive coverage of food and feed enzyme production and use in the key global markets.

1.2. OBJECTIVES

- To identify supply, demand and trends for selected enzymes in food/drink and animal feed
- To examine the factors for and against change and the impact which these have on enzyme use by food, drink and animal feed producers
- To evaluate the impact of market trends such as clean-label and the acceptance of enzymes produced using GM-organisms
- To identify the current (2015) market size and provide forecasts to 2020

1.1. SCOPE

1.2.1. PRODUCTS

Enzymes used in food, beverage and animal feed applications

1.2.2. END USER SECTORS

- Bakery/Cereals: flour, bread, noodles...
- Alcoholic drinks: beer, wine-making, distilled alcoholic beverages
- Fruit processing
- Dairy
- Protein hydrolysis: HVP/HAP, fish sauce, nucleotides, protein derivatives
- Animal feed (including aquaculture)

1.2.3. GEOGRAPHICAL

USA, EU28, India, China

1.2.4. TIMESCALE

Current (2015) production and consumption and forecast 2020

2. EXECUTIVE SUMMARY

2.1. INTRODUCTION

Enzymes find application in a wide range of industrial applications in food/beverage, animal feed and non-food (textiles, detergents, biofuels, etc.).

Use of enzymes is growing in many sectors. Enzymes from specifically selected, or engineered, microorganisms can boost yields, facilitate production of preferred molecules and generate significant savings in processing various substrates.

As the market for enzymes has developed the number of producers worldwide has grown. In total more than 50 players, many of these in Asia (especially in China) are involved in enzyme manufacturing. Next to these manufacturers a large number of blenders or formulators, which focus on blending enzymes for specific applications, have emerged, often specialising in specific sectors.

The major manufacturers of enzymes can be grouped as follows:

- Pure-play: Novozymes, AB Enzymes, Amano, Advanced Enzymes
- Ingredient suppliers: DuPont, DSM, BASF
- Specialists (single segment):
 - Chr Hansen (Dairy)
 - Lyven (Fruit + Wine)
 - AB Vista (Feed)

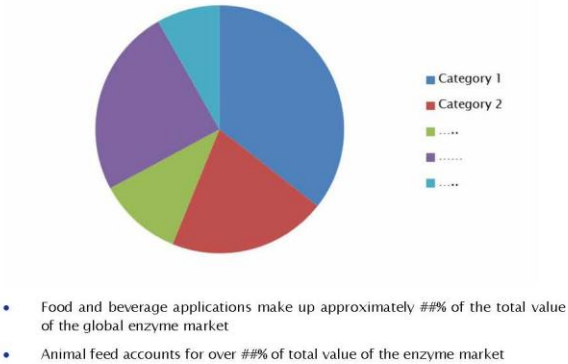
Traditionally, major enzyme manufacturing sites are located in Europe and Japan. China and India are emerging sources of supply. While exports from local players in these countries remain limited, Novozymes has established production facilities in both countries and its Hongda (Suzhou) plant is now its largest production site. Other countries with significant enzyme manufacturing include Taiwan and South Korea.

This study focusses on enzymes used in food/beverage and animal feed applications, produced or consumed in USA, Europe, China and India

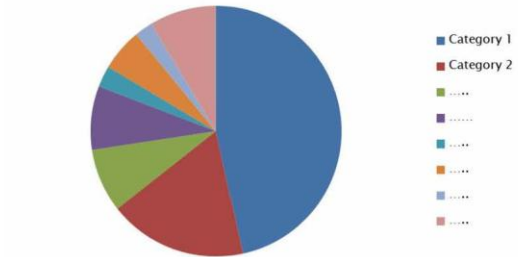
2.1.1. GLOBAL ENZYME MARKET

The value of the global (all territories, all applications) enzyme market is estimated at EUR ### bio in 2015.

Estimated global market for industrial enzymes, 2015, EUR mio #Data edited#



Estimated producer shares in global industrial enzyme market, 2015 (by value) #Data edited#

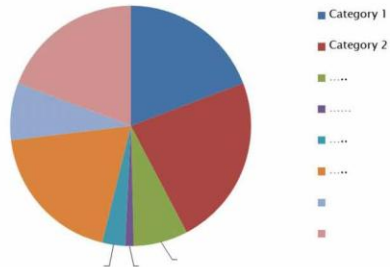


- Novozymes is, by far, the largest supplier of industrial enzymes globally with a share approaching half the market by value
- By volume, Chinese players dominate, selling vast volumes of low concentration, and low value enzyme products. Volumes in feed are particularly significant
- The shares of enzymes manufactured by different producers in specific markets are highly variable for a number of reasons including:
 - Enzyme suppliers seek to offer clients a full range of enzyme products. Where a given supplier does not have direct access to manufacture a specific type of enzyme (due to technological or IP limitations), it secures supply from another producer
 - Partnerships in specific sectors such as the Feed Enzymes Alliance created in 2001 by DSM and Novozymes or Oenobrand, a 50/50 JV between DSM and Lallemand to supply enzymes for winemaking
 - Suppliers with a strong position in ingredients for specific end-use markets, such as Chr Hansen in cheese and other dairy markets, seek to complete their product offer with enzymes sourced from specialist producers. In the case of Chr Hansen, enzymes sold to the dairy industry are sourced from Novozymes and Amano

2.1.1.1 FOOD & BEVERAGES

Food and beverages market estimated at EUR ## bio (including starch processing).

Enzymes for food and beverages, split by sector, 2015, EUR mio #Data edited#



2.2. SUPPLY

2.2.1. PRODUCTION

Key production sites and estimated production volumes for suppliers operating in the regions covered in the study are listed below (volumes refer to food/beverage and animal feed enzyme manufacturing only)

Food/beverage & feed enzyme production 2015

Producer	Region	Production (t)
Novozymes	USA	...
DuPont	USA	...
Chr Hansen	USA	...
Others	USA	900
Sub-total USA		...
Novozymes	Europe	...
AB Enzymes	Europe	...
DSM	Europe	...
DuPont	Europe	...
...	Europe	1650
...	Europe	1050
...	Europe	...
...	Europe	...
...	Europe	...
...	Europe	...
Others	Europe	...
Sub-total Europe		...
Novozymes	China	...
Genencor (DuPont)	China	...
Pangbo	China	...
...	China	8500
...	China	8000
...	China	...
...	China	...
Leveking	China	...
...	China	...
Longda	China	...
...	China	...
...	China	...
...	China	5500
Doing-Higher	China	...
VTR-Biotech	China	...

Section: Executive Summary

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Producer	Region	Production (t)
Others	China	****
Sub-total China		****
Advanced Enzymes	India	****
Maps Enzymes	India	****
****	India	****
****	India	****
Others	India	****
Sub-total India		****
Total		****

Source: Giract based on database and interviews

- Volumes estimated for Chinese producers, especially in the area of feed enzymes, are high due to the production of low activity enzymes

2.2.2. GLOBAL SUPPLIERS (DATA EDITED)

2.2.2.1 AB ENZYMES

- Broad portfolio of enzymes covering applications in food/beverage and animal feed – strong position in feed through AB Vista
- Liquid (submerged) fermentation using both classical and GM-strains (*Trichoderma*, *Bacillus*, *Aspergillus*)
- All production is carried out in Finland by ROAL a joint-venture between AB Enzymes and Altia. Applications support in Germany for food/beverages and UK for animal feed
- Mergers & Acquisitions – in addition to the JV with Altia
 - GENEDATA (Switzerland) – agreement to use Genedata Selector for the selection and optimisation of strains for enzyme production
 - BARENTZ (Netherlands) – long-standing agreement for the distribution of AB Enzymes products in Europe and since 2013 Turkey
 - BEHN MEYER (Germany) – exclusive distributor for AB Enzyme products across selected countries in SE Asia

Section: Executive Summary

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AB Enzymes – SWOT analysis

Strengths	Weaknesses
Comprehensive enzyme portfolio and access to	Production ####
####	Dependent #### for some enzymes
Strong position in feed enzymes ####	Limited visibility of ####
Cost ####	
Opportunities	Threats
Growing demand for #### enzymes in emerging markets (####, ####, ###)	Competition from #### with #### cellulases and proteases in India & China
	Scale, focus and #### of #### business within #### & ####

2.2.2.2

AMANO

- ### enzyme producer in Japan with a broad portfolio of enzymes covering applications in food, food supplements, pharmaceutical, diagnostic and bioconversions
- Fermentation at ## locations in Japan. Low cost amylase for local sales into starch conversion produced in China. Blending/formulating for the US market in Elgin (IL)

AMANO – SWOT analysis

Strengths	Weaknesses
Opportunities	Threats

2.2.2.3

BASF

-
-
-
-

Section: EU28/Norway/Switzerland

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5.6.2. ENZYME USE IN BREWING

5.6.2.1 TYPES & ORIGIN

Enzyme use in beer production

End-use sector	Function of Enzyme	Type of Enzyme
Beer	Hydrolyse starch, adjunct liquefaction, reduce viscosity, improves malt	Amylase
Beer	Fermentation yield improvement, reduce viscosity of beer and mash, beer clarity	Glucoamylase
Beer	Hydolyse glucans, aid in filtration, improve wort separation	Beta-Glucanase
Beer	Hydrolyse xylans (pentosans) of wheat, barley and malt	Xylanase
Beer	Converts α-acetolactate to acetoin directly, Decrease fermentation time by avoiding formation of diacetyl, speed up beer maturation process	Alpha-Acetolactate Decarboxylase
Beer	Modify protein-polyphenolic compounds, reduced chill haze formed in beer	Protease

Source: Giract based on publications and database

- Enzymes from microbial sources are used in flavor control, beer stability, reducing environmental emissions and saving cost
- Enzymes are important due to widespread usage of grains (rather than, for example, rice) as the main raw material for manufacturing beer
- Enzymes improve yields, reduce waste and by-products and improve productivity
- Commercial exogenous enzymes have advantages over traditional malting (which releases enzymes) as these enzymes are effective over wider ranges of temperature and pH. Thus, use of enzymes in various steps in the brewing helps in making the process easier, faster and more consistent

Section: EU28/Norway/Switzerland

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5.6.2.2 ENZYME MARKET

Market Shares for Enzyme Products

Enzyme products	GM-origin	Market Share (% of Total)
Amylase	Yes	##
Glucoamylase	Yes	##
Beta-glucanase	Yes	##
Xylanase	Yes	##
Alpha-acetolactate	Yes	##
Protease	Yes	8

Source: Giract based on database and interviews

- The brewing enzymes market in Europe is estimated to be valued at around EUR ## mio in 2015, about ##% of the global market for brewing enzymes
- GMO is a significant issue in the region, for example, Heineken – a leading player in the European beer market has a policy to not use enzymes sourced from GM microorganisms
- Enzyme usage is not permitted in Germany and Czech Republic as per the Reinheitsgebot (German Beer Purity Law) which allows only hops, water and barley (or other grains) to be used to make the brew

Section: EU28/Norway/Switzerland

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5.6.2.3 AMYLASE

Suppliers and Major Brand Names

Supplier	Brand name	Notes
AB Enzymes	Rohalase	Amylase for liquefaction of mashes
Amano Enzymes	Kleistase	Non-GM Can be used in brewing application and alcohol production
Kerry Group	HiTempase, Bioferm	
Lyven	Amylyve	Production of light beers, sourced from both GM and non-GM strains
Lyven	Amylyve UHT	For crude grain liquefaction (rice, corn, sorghum etc.) at high temperature (80–90°C
Novozymes	Termamyl Classic	Non-GM, heat-stable alpha-amylase for the liquefaction (thinning) of adjunct mashes.
DSM	Mats L Classic	Liquid enzyme for starch liquefaction
DSM	Mycolase	Fungal alpha-amylase for starch conversion especially with adjunct brewing
Novozymes	Termamyl SC DS	GM, heat-stable alpha-amylase for the liquefaction (thinning) of adjunct mashes. Liquefaction enzyme that can operate at lower pH and lower calcium levels than conventional thermostable alpha-amylases
DuPont	Amylex	Used in mash and cereal cooker applications; it secures efficient starch extraction and liquefaction and reduced viscosity

Source: Giract based on database and publications

- Amylase usage is increasing to optimise yields and mitigate increases in raw material costs and to allow replacement of malt by cheaper sources of starch
- Amylases used in brewing applications may be derived from genetically modified microorganisms

Section: China

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6.11.1. BEIJING HUIYUAN GROUP
Huiyuan Road, Beixiaoying Town
Shunyi District, Beijing
China
Tel: +86 10 60483388
www.huiyuan.com.cn/

Relevant products

NFC (not from concentrate, fresh) fruit and vegetable juices

Background

The annual turnover of Huiyuan is over CNY 4.5 bio and it is the largest juice drinks manufacturer in China. The company processes about ## mio tons of fruit per annum to produce fruit pulp and juice concentrates from apple, peach, pear, apricot, strawberry, orange, jujube, haw berry, kiwi berry, oleaster, etc. Its main products are 100% juice and juice drinks. It also imports fruit pulp and fruit juice concentrates from Brazil and Southeast Asia.

Awareness and current use of enzymes

The company uses #####, pectinase and a blend of pectinase and ##### mainly in NFC juices. It sources ##### from various suppliers including Novozymes, #####, #### and other Chinese suppliers at a price of CNY ##-##/kg. This enzyme is used at a dosage of ##-## kg/ton of fruit. Enzyme activity is in the range ##000-##000IU/g. ##### is used for the saccharification of the starch in the fruit to glucose and other soluble saccharides. This avoids deposition of large starch molecules and provides clear and stable fruit juices. It is commonly used in the processing of apples, pear and kiwi juices.

The company purchases pectinase from various suppliers including ####, #####, and other local suppliers at the price of CNY ##-#0/kg, dosage varies over a wide range of ##-## ppm, depending on the type of fruit being processed. Enzyme activity is in the range ##000-##000IU/g. Pectinase is used to decompose pectin in the fruit pulp to improve juice yield rate, improve the filtration process and produce clear juice products. Dosage of pectinase varies on the fruit type and natural pectin content, for example: #0-#0 ppm (apple, pear juices), #0-##0 ppm (grape juice), ###-## ppm (strawberry juice), #00-##0 ppm (haw juice), ###-## ppm (lemon juice) and ###-## ppm (mango juice).

Section: China

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Enzyme blend containing pectinase and ### is purchased as fruit pulp enzyme from ##### and other local suppliers at a price of CNY ##/kg. This enzyme blend is used to decompose pectin and break cell walls, in order to increase juice release and improve over % of juice yield rate. Enzyme activity is around ###00-##000IU/g and it is used at a dosage of ##-##g/ton (or ##-## ppm).

Sourcing & supply of enzymes

and pectinase are purchased as single component, whereas fruit pulp enzyme is a blend of pectinase and #####. These enzymes are sourced from manufacturers, distributors or from premix producers. The company purchases all the raw materials and ingredients at its regional plants, rather than through the headquarters. It also imports large volumes of juice concentrates from overseas countries, no enzymes are required form further processing.

Company views on enzymes

The company uses enzymes mostly from Chinese manufacturers and distributors. Enzymes are considered as natural and cost-effective for fruit juice processing.

Future prospects for enzyme use

The fruit juice market in China is currently expanding at a very slow rate. The company's sales have grown at only % in 2014. Slow growth is impacting enzyme use in the juice sector and the company expects that growth will be in the range of #-##%/year over the next 5 years.

6.11.2. BEIJING SDIC ZHONGLU FRUIT JUICE
2 Buchengmenwai Avenue, Xicheng
Beijing
China
Tel: +86 10 88009085
www.sdiczl.com

Relevant products

NFC fruit and vegetable juices

Background

The total sales revenue of the Zhonglu was around CNY ### mio (USD ### mio) in 2014. The company is owned and invested by State Development & Investment Corporation (SDIC). It is one of the largest fruit and vegetable processing company in China with 10 fruit processing facilities. It mainly exports juice concentrates to various countries including Japan and generates over ##% of its revenue from export.