

CONTENTS

VOLUME VI

Biopesticide Production**1**Nasrine Moazami, *Iranian Research Organization for Science & Technology [IROST], Iran*

1. Introduction
2. Biological Control
3. Microbial Insecticides
 - 3.1 *Bacillus thuringiensis*
 - 3.1.1 General Overview
 - 3.1.2 Mode of Action
 - 3.2 *Bacillus Thuringiensis* Var.kurstaki
 - 3.3 *Bacillus Popilliae* and *Bacillus Lentimorbus*
 - 3.4 *Bacillus Thuringiensis* H-14
 - 3.5 *Bacillus Sphaericus*
4. Production of *Bacillus Thuringiensis* and *Bacillus Sphaericus*
 - 4.1 Culture Maintenance and Preservation
 - 4.1.1 Liquids
 - 4.1.2 Materials of Plant Origin
 - 4.1.3 Materials of Animal (nonmammalian) Origin
 - 4.1.4 Materials of Mammalian Origin
 - 4.1.5 Minerals
 - 4.2 Fermentation
 - 4.3 Recovery Process
 - 4.4 Formulation and Storage
 - 4.5 Bioassay Protocol for *Bacillus Thuringiensis* and *Bacillus Sphaericus* Preparations
 - 4.5.1 Standard Bacterial Preparation
 - 4.5.2 Assay Species
 - 4.5.3 Preparation and Reading of the Bioassay
 - 4.5.4 Calculation of Potency in International Units (IU)
 - 4.6 Bioassay Protocol for *Bacillus thuringiensis* H-14 Preparations
 - 4.6.1 Standard Bacterial Preparation
 - 4.6.2 Assay Species
 - 4.6.3 Calculation of Potency in International Units (IU)
 - 4.7 Safety and Quality Control
 - 4.7.1 Chemical Contamination
 - 4.7.2 Microbial Contamination
 - 4.8 Packaging and Distribution
5. Entomopathogenic Viruses
 - 5.1 General Overview
 - 5.2 Baculoviruses (Baculoviridae)
 - 5.2.1 Life Cycle
 - 5.2.2 Relative Effectiveness
 - 5.2.3 Appearance
 - 5.2.4 Habitat
 - 5.2.5 Current use of Baculoviruses as Insecticides
6. Entomopathogenic Fungi
 - 6.1 Formation of an Infection Structure
 - 6.2 Penetration of the Cuticle
 - 6.3 Production of Toxins
 - 6.4 Mode of Action
 - 6.5 *Lagenidium Giganteum*
 - 6.6 *Verticillium Lecanii*
7. Biopesticide Production

- 7.1 Use of New Genetic-Engineering Technology
- 7.2 Engineering Biological Control Agents
- 7.3 Engineering Crop Plants
- 8. Entomopathogenic Protozoa and Microsporida
- 9. Entomopathogenic Nematodes
- 10. Biological Control of Aflatoxin Contamination of Crops
- 11. Integrated Pest Management
- 12. Market
- 13. Conclusion

Secondary Products from Plant Tissue Cultures

53

James C. Linden, *University of Colorado, USA*

- 1. Diversity and potential of plant cell culture
- 2. Regulation of production through elicitation and induction
 - 2.1 β -glucans
 - 2.2 Ethylene
 - 2.3 Methyl jasmonate
 - 2.4 Interactions between elicitors and signals
- 3. Preliminary economics of using plant cell culture for secondary metabolite production
- 4. Limitations/opportunities for marketing plant cell culture products
- 5. The future for secondary products from plant tissue culture

Industrial Mycology

75

Stefan Rokem, *The Hebrew University of Jerusalem, Israel*

- 1. Introduction
- 2. Product range
 - 2.1 Metabolites
 - 2.2 Enzymes
 - 2.3 Biomass
 - 2.4 More recent and potential products
- 3. Solid State Fermentation
 - 3.1 Products from Solid State Fermentation
 - 3.1.1 Gibberellic acid – GA₃
 - 3.1.2 Glucoamylase
- 4. Submerged Fermentation
 - 4.1 Selected metabolites produced by Submerged Fermentation
 - 4.1.1 Lovastatin
 - 4.1.2 Red Monascus Pigments
 - 4.1.3 Rennet (Chymosin) from Mucor
 - 4.1.4 Quorn®
- 5. Other Developments of Industrial Mycology
 - 5.1 Heterologous Proteins by Filamentous Fungi
 - 5.2 Flavoring Agents
 - 5.3 Cheese Made with Fungi
 - 5.4 Higher Fungi for Food Flavor and Medicine
- 6. Conclusions

Biobutanol

98

D. T. Jones, *Department of Microbiology and Immunology, University of Otago, Dunedin, New Zealand*

- 1. Introduction
- 2. Biobutanol
 - 2.1. Properties of Biobutanol as a Liquid Transportation Fuel

- 2.2. Energy Content
- 2.3. Octane Rating and Vapour Pressure
- 2.4. Water Tolerance
- 2.5. Compatibility with Existing Internal Combustion Engines
- 2.6. Co-blending Features
- 2.7. Handling and Distribution Advantages
- 2.8. Synergies with Bioethanol and Biodiesel
- 2.9. Feedstock Flexibility and Agricultural Benefits
- 2.10. Environmental Benefits
3. Development of the Industrial ABE Fermentation Process
 - 3.1. Origins and Early History
 - 3.2. The Development of the Commercial Fermentation Industry
 - 3.3. The Rise and Decline of the Commercial ABE Fermentation Process
4. The Commercial ABE Fermentation Process
 - 4.1. Raw Materials
 - 4.2. Microorganisms Seed Cultures and Inoculum Procedures
 - 4.3. The Starched-based Batch Fermentation Process
 - 4.4. The sugar-based Batch Fermentation Process
 - 4.5. Product Recovery Processing and Usage
5. Limitations of the Industrial ABE Fermentation Process
 - 5.1. Complex Two Phase Batch Fermentation
 - 5.2. Solvent Yields and Ratios
 - 5.3. Butanol Toxicity and Low Final Solvent Concentrations
 - 5.4. Susceptibility to Contamination and the Requirement for Sterility
 - 5.5. Low Value By-products and Effluent Disposal
 - 5.6. Culture and Strain Stability and Reliability
 - 5.7. Negative features of bulk chemical production by fermentations
6. Economic Perspectives
 - 6.1. Economics of the Conventional Batch ABE Fermentation Process
 - 6.2. The Solvent Market
 - 6.3. The Biofuels Market
7. Advances in Scientific Know-how
 - 7.1. Strain Development and Improvement
 - 7.2. Genetic Engineering
 - 7.3. Metabolic Engineering
 - 7.4. Alternative Production Systems
8. Advances in Process Technology
 - 8.1. Continuous Culture Systems
 - 8.2. Solvent Extraction and Recovery Processes
 - 8.3. Continuous Fermentation and Solvent Removal Systems
9. Utilization of Lignocellulosic Substrates
 - 9.1. Concerns Relating to Use of Food Crops for Biofuel Production
 - 9.2. Use of Alternative Substrates for the ABE Fermentation
 - 9.3. Physical and Chemical Degradation Technologies
 - 9.4. Genetic Manipulation
10. Conclusions and Future Prospects

Industrial Use of Enzymes

135

Michele Vitolo, , *Brazil*

1. Introduction
2. Sources of Enzymes
3. Enzyme Production
 - 3.1. An Overview on Downstream Processing
 - 3.1.1. Filtration
 - 3.1.2. Centrifugation and Sedimentation
 - 3.1.3. Flocculation and Coagulation

- 3.1.4. Cell Disruption
- 3.1.5. Extraction
- 3.1.6. Precipitation
- 3.1.7. Chromatography
- 3.1.8. Finishing Operations
 - 3.1.8.1. Crystallization
 - 3.1.8.2. Drying
 - 3.1.8.3. Formulation
 - 3.1.8.4. Some Aspects on Safety in Handling Enzymes
- 3.1.9. Invertase Production: As a Case
- 4. Fundamentals on Enzyme Kinetic
 - 4.1. Introduction
 - 4.2. Specificity
 - 4.3. Enzyme Activity
 - 4.3.1. Quantification of the Enzyme Activity
 - 4.3.2. Expression of the Enzyme Activity
 - 4.3.3. Factors Affecting the Enzyme Activity
 - 4.3.3.1. Physical-Chemical factors
 - 4.3.3.1.1. Ph
 - 4.3.3.1.2. Temperature
 - 4.3.3.1.3. Miscellaneous
 - 4.3.3.2. Chemical Factors
 - 4.3.3.2.1. Activators
 - 4.3.3.2.2. Stabilizers
 - 4.3.3.2.3. Inhibitors
 - 4.3.3.3. Physical Factors
 - 4.3.4. Briefing on Thermodynamic of the Enzyme catalysis
 - 4.3.5. An Overview on Enzyme Immobilization
- 5. A Briefing on the Uses of Enzymes
 - 5.1. Baking
 - 5.2. Starch Conversion
 - 5.3. Protein Modification with Enzymes
 - 5.3.1. Introduction
 - 5.3.2. Brewing
 - 5.3.3. Dairy Industry
 - 5.3.4. Miscellaneous uses of Proteolytic Enzymes
 - 5.4. Enzymes in Fruit Juices
 - 5.5. Miscellaneous
 - 5.5.1. Detergents
 - 5.5.2. Effluent and Waste Treatments
 - 5.5.3. Flavor Production with Enzymes
 - 5.5.4. Leather
 - 5.5.5. Textiles
 - 5.5.6. Pulp and Paper
 - 5.5.7. Edible Oils
 - 5.5.8. Enzymes in Animal Feeding
 - 5.5.9. Enzymes as Analytical Tools
 - 5.5.10. Enzymes as Medicines
 - 5.5.11. Enzymatic Biotransformations
- 6. Conclusion

Production of Heterologous Hydrolysis Enzymes within Crop Biomass for Biofuel Ethanol 220

Mariam B. Sticklen, *Michigan State University, USA*

Callista Ransom, *Michigan State University, USA*

- 1. Introduction
- 2. The Plant Cell Wall

- 2.1 Cell wall components
 - 2.1.1 Cellulose
 - 2.1.2 Cross-linking glycans
 - 2.1.3 Pectins and other substances
 - 2.1.4 Lignin
- 2.2 Two major types of primary cell wallsystemsystem
- 3. Cell wall degradation
 - 3.1 Microorganisms
 - 3.2 Hydrolysis
 - 3.2.1 Cellulases
 - 3.2.2 Hemicellulases
 - 3.2.3 Ligninases
- 4. Ethanol production
 - 4.1 Maize grain ethanol production
 - 4.2 The promise of cellulosic ethanol
 - 4.2.1 Cellulosic ethanol production
 - 4.2.2 Challenges to cellulosic ethanol production
- 5. Production of Hydrolysis Enzymes in Biomass Crops
 - 5.1 Plants as molecular biofactories
 - 5.2 Successful plant-produced hydrolysis enzymes
 - 5.3 TSP must be extracted prior to pretreatment
 - 5.4 Thermostable enzymes are desirable
 - 5.5 Subcellular targeting and sequestration
- 6. Other Approaches
 - 6.1 Microbial engineering
 - 6.2 Lignin pathway manipulation
 - 6.3 Up-regulation of cellulose pathway genes to increase sugar content
 - 6.4 Delayed flowering to increase biomass
 - 6.5 Genetic manipulation to increase biomass
- 7. Conclusion

Index **245**

About EOLSS **251**