Numerous foods are prepared by fermentation processes in which one or more kinds of microorganisms are responsible for the characteristic flavour or texture, and sometimes for the keeping quality of the product. The manufacture of fermented food products is carried out on a small scale in homes in every country. Fermented products are more palatable and are not as easily spoiled as the natural products. The microorganisms that produce the desirable changes may be the natural flora on the material to be fermented, or may be added as starter cultures.

The yield of organic acids principally lactic, serve as a preserving agents. Lactic acid fermentation is an anaerobic intramolecular oxidation reduction process. Both homofermentative and heterofermentative lactic acid bacteria participate in food fermentations. In some fermented food products, yeasts and moulds also participate along with lactic acid bacteria.

Most of the reactions in living organisms are catalyzed by protein molecules called enzymes. Enzymes can rightly be called the catalytic machinery of living systems. The real break through of enzymes occurred with the introduction of microbial proteases into detergents. Most of the enzymes are produced by microorganisms in submerged cultures in large reactors called fermentors. In choosing the production strain several aspects have to be considered. Industrial enzyme market is growing steadily. The reason for this lies in improved production efficiency resulting in cheaper enzymes, in new application fields. Tailoring enzymes for specific applications will be a future trend with continuously improving tools and understanding of structure-function relationships and increased search for enzymes from exotic environments. This field deals with how are the enzymes used and applied in practical processes. A lot of fungal, bacterial and actinomycete strains with potential for producing novel industrial enzymes have been identified.

This book contains sterilization, fermentation processes, aeration and agitation, use of yeast, yeast production, fermentation raw materials, production of bacterial enzymes, bread making methods, effluent treatment, production of actinomycete protease, lactic acid, citric acid. This handbook will be very helpful to its readers who are just beginners in this field and will also find useful for upcoming entrepreneurs, existing industries, food technologist, technical institution etc.

Contents

1. The Development of Inocula for Industrial Fermentations
   Introduction
   The development of inocula for yeast processes
   Brewing
   Bakerâ€™s Yeast
   The development of inocula for bacterial processes
The development of inoculum for fungal processes
Sporulation on Solidified Media
Sporulation on Solid Media
Sporulation in Submerged Culture
The Use of the Spore Inoculum
Inoculum Development for Vegetative Fungi
The Effect of the Inoculum on the Morphology of Fungi in Submerged Culture
The development of inoculum for streptomycete processes
The aseptic inoculation of plant fermenters
Inoculation from a Laboratory Fermenter or a Spore Suspension Vessel
Inoculation from a Plant Fermenter

2 An Introduction to Fermentation Processes
Lactate
Acataldehyde
Acatalactate
Butanediol
Ethanol
The range of fermentation processes
Microbial Biomass
Microbial Enzymes
Microbial Metabolites
Transformation Processes
The chronological development of the fermentation industry
The component parts of a fermentation process

3. Sterilization
Introduction
Medium sterilization
Advantages of Continuous Sterilization over Batch Sterilization
Advantages of Bath Sterilization over Continuous Sterilization
The design of batch sterilization processes
Calculation of the Del Factor during Heating and Cooling
Calculation of the Holding Time at Constant Temperature (121°C)
Richardsâ€™ Rapid Method for the Design of Sterilization Cycles
The Scale Up of Batch Sterilization Processes
Method of Batch Sterilization
The design of continuous sterilization processes
Sterilization of the fermenter
Sterilization of the feeds
Sterilization of Air
The Theory of Fibrous Filters
Filter design

4. Media for Industrial Fermentations
Introduction
Typical media
Medium formulation
Water
Energy sources
Carbon sources
Examples of Commonly Used Carbon Sources
Factors Influencing the Choice of Carbon Source
The Influence of the Carbon Source on Product Formation
Nitrogen sources
Examples of Commonly Used Nitrogen Sources
Factors Influencing the Choice of Nitrogen Source
Vitamin sources
Nutrient recycle
Buffers
The addition of precursors and metabolic regulators to media
Precursors
Inhibitors
Inducers
Oxygen requirements
Fast Metabolism
Rheology
Restricted nutrient levels
Antifoams

5. Aeration and Agitation
Introduction
The oxygen requirements of industrial fermentations
Glucose
Oxygen supply
Determination of Kla values
Gassing-out techniques
The static method of gassing out
The dynamic method of gassing out
Fluid rheology
Bingham Plastic Rheology
Pseudoplastic Rheology
Dilatant Rheology
Casson Body Rheology
Factors affecting Kla values in fermentation vessels
The Effect of Air-Flow Rate on Kla
The Effect of the Degree of Agitation on Kla
The relationship between Kla and power consumption
The relationship between power consumption and operating variables
The Effect of Medium and Culture Rheology on Kla
Medium rheology
The effect of microbial biomass on Kla
The effect of microbial products on aeration efficiency
The Effect of Foam and Antifoams on Oxygen Transfer

6. Mushrooms
Mushrooms and single-cell (microbial) protein
Production of the oyster mushroom, Pleurotus Species
Methods of Cultivation
Economics of Industrial Production
Growth of Pleurotus Ostreatus on Waste Paper
Growth of Pleurotus ostreatus on waste paper
Production of volvariella volvacea: straw mushrooms
Description
Patterns of Production and Consumption
Steps in Production
Factors Controlling Mushroom Production
Harvesting and Preservation
Discussion of Processing Steps
Preservation of Straw Mushrooms
Nutritional Content
New Microbial Strains
Expansion of Straw Mushroom Production
Edible termitomyces and their culture in the laboratory
Collection and Identification of Termitomyces Species
Culture of the Edible Species
Effect of Culture Media on Mycelia Growth
Effect of Light, Temperature, and pH on Mycelial Growth
Spawn Formation
Fruiting Body Formation
Results and Discussion
Isolation in Pure Culture
Effect of Culture Media
Effect of Temperature
Effect of Light
Effect of pH
Spawn and Fruiting Body Formation

7. Use of Yeast in Baking
Historical Introduction
Function of yeast in baking
Leavening
Effect of Yeast on Dough Development
Flavour Development
Forms of yeast used in baking
Compressed Yeast
Active Dry Yeast
Yeast for Home Baking
Yeast of Enrichment
Behaviour of yeast in dough systems
Use of Yeast in Various Dough Systems
Growth of Yeast in Doughs
Accelerated Processing of Yeast-raised Products
Yeast-leavened, Unbaked, Frozen Doughs
Sour Doughs

8. Distillers’ Yeast
Introduction
Raw materials
Yeast preparation
Distillers’ Yeast
Inoculation of Yeast Mashes from Preceding Mashes
Inoculation of Yeast Mashes with Laboratory Pure Cultures
Use of Compressed or Active Dry Bakers’ Yeast
Distillers’ fermentations
Contaminants
Distillation
Composition of distilled spirits
9. Brewersâ€™ Yeast
Introduction
General characteristics of brewersâ€™ yeasts
Specific characteristics of brewersâ€™ yeasts
Flocculation
Wild Yeasts
Yeasts Cultivation and Pitching
Nitrogen Metabolism of Brewers; Yeast
Vitamin Requirements
Mineral Requirements
Fermentation of Wort Sugars
Effect of Temperature and Other Variables on Rate and Time of Fermentation
Growth of Yeast
By-products of alcoholic fermentation
Higher Alcohols (Fusel Oils)
Esters
Diacetyl, Acetoin, 2, 3-Butanediol, and 2, 3-Pentanedione
Aldehydes
Glycerol
Acids
Sulfur Compounds
Processing
Generation of Heat
Batch Fermentations and Modified Batch Fermentations
Continuous Fermentation
Microbial Stability of Beer
Adsorption of Isohumolone and Anthocyanins by Yeast

10. Wine Yeasts
History
Wine yeast terminology
Description of species
Natural yeasts and their occurrence in grapes and musts
Fermentation by natural yeasts and by wine yeasts
Production of wine yeast starters
Compressed wine yeast and active dry wine yeast
Biochemistry of wine yeast fermentations
Rate of Fermentation
Effect of Temperature
Fermentable Sugars in Musts and Yield of Ethanol
Effect of Carbon Dioxide Pressure on Fermentation
Effect of Ethanol on Fermentation Rate
Effect of pH on Rate of Fermentation
Sulfur Dioxide
Diethyl Pyrocarbonate (DEPC)
Sorbic Acid and p-hydroxybenzoic Acid Esters
Tannins
Ion-exchange Resins, Antibiotics and Fungicides
By-products of the alcoholic fermentation, flavor compounds, acids and yeast nutrients
Introduction
Alcohols
Aldehydes
Glycerol, 2,3-Butylene Glycol, Acetoin and Diacetyl
Esters
Malic Acid and the Malo-lactic Fermentations
Acids
Nitrogenous Compounds
Sulfur Compounds
Vitamin Requirements of Wine Yeasts
Production of wines
Introduction
Red and White Table Wines
Sherry
Sparkling Wines
Fermentation of Uncrushed Grapes (Maceration Carbonique)
Continuous Fermentation
Cider and Other Fruit Wines

11. Bakers’ Yeast Production
History
Outline of the manufacturing process
Raw materials
Molasses
Minerals
Vitamins
Nitrogen
Fermentation Activators
Fermentation Inhibitors
Principles of aerobic growth of bakers’ yeast
Introduction
Concentration of Fermentable Sugars
Limitation of Yeast Growth Rate
Oxygen Requirements and Aeration
Effect of pH
Temperature
Yield Energy, and the Development of Heat
Osmotic Pressure
Yeast Concentration in the Fermenter
Periodicity and Budding
Practice of the aerobic growth of bakers’ yeast
Fermentation Tanks
Cooling
Aeration Systems
Feed Rates
Sequence of Fermentations
Defoaming
Utilization of Ethanol
Automatic Process Control
Continuous Aerobic Propagation of Bakers’ Yeast
Harvesting of Yeast Cells
Mixing, Extruding and Packaging Compressed Yeast
Contamination
Stability of Compressed Yeast
Active Dry Yeast

12. Lactic Acid CH₃CHOHCOOH
From whey by Fermentation
Reaction
Material Requirements
Process
From Lactonitrile
Use Pattern
Miscellaneous
Economic Aspects

13 Citric Acid
From Molasses by Fermentation
Reaction
Material Requirements
Process
By Submerged Fermentation
Use Pattern
Miscellaneous
Economic Aspects

14. A Milk-Bottle Fermentation

15. The Fermentor: An Elaborate Milk Bottle

16. Fermentation Raw Materials

17. A Typical Industrial Fermentation

18. Production of Actinomycete Protease by Solid-State Fermentation and its Application in Dehairing of Goatskin
   Introduction
   Materials and methods
   Isolation of Proteolytic Soil Actinomycetes
   Dehairing of Goatskins
   Analyses
   Determination of Protein
   Protease Assay
   Results
   Isolation of Proteolytic Soil Actinomycetes
   Discussion

19. Fermented Vegetables
   Introduction
   Theory behind fermented vegetables
   Indian or oriental fermented vegetables
   Fermented vegetables of the west
   Advantages of Fermented Vegetables: Disadvantages of Fermented Vegetables

20 Production of Bacterial Extracellular Enzymes by Solid State Fermentation
   Introduction
   Materials and methods
   Bacterial Strains
   Enzyme Production in SSF
   Amylase Production vs. Incubation Period
Effect of Moisture Level
Effect of Various Additives
Solid State Cultivation in Trays
Enzyme Assays
Results and discussion

21. Fermented Products
General procedure
Tips
Simple Bread
Method
Round bread
Method
Tiger Skin Bread
Method
Seasoned Bread
Method
Malteser Bread
Method
French Bread
Method
Tips
Rich bread
Method
Cinnamon Sugar bread
Method
Other bread
Method
Potato barm bread
Method
Bread (sponge & Dough Method)
Method
Toast/ Rusk
Method
Rusk
Method
Tip
Bun / Roll
Method
Soup Stick
Method
Plaited Bun: Winston
Method
Plaiting with 2-strings
Plaiting with 3-strings
Plaiting with 5-strings
Plaiting with 4-strings
Plaited with 6-strings
Winstone
Tip
Seli Bun
Method
Basic sweet dough
Method
Butterfly bun
Method
Nutty Rolls
Method
Jam filled buns
Method
Cheese cake
Method
Hot cross bun
Method
Dutch bread
Method
German coffee cake
Method
German Coffee Cake (Coconut)
Method
Yeast raised fruit cake
Method
Doughnut
Raised doughnut
Method
Cake doughnut
Method
Combination doughnut
Method
Variation
Fruit finger doughnut
Jam ball doughnut
Masala doughnut
Pitza
Pitza base
Method
Vegetable Pitza
Method
Gravy Pitza
Method
Variations
Chanou Pitza
Method
Assembling (Base and Filling)
Surti Butter
Method
Stuffed Products
Burger
Tip
Variation
Tips
Sandwich
Method
Tips
Variations
Tips
Stuffed rolls
Method

Danish Pastry
Method
Filling Preparation
Variety 1
Variety-2
Danish comb
Method
Cinnamon roll
Method
Croissant
Method
Pinwheel
Method

22. Bread Characteristics
Introduction
External characteristic
Volume
Bloom
Crust Colour
Factors Affecting the Crust Colour
Evenness of Bake
Factors Affecting Evenness of Bake
Oven Break
Factors Affecting Oven Break
Internal characteristics
Crumb Colour
Factors Affecting Crumb Colour
Crumb Structure
Factors Affecting Crumb Structure
Crumb Clarity and Elasticity
Crumb Clarity
Crumb Elasticity
Sheen and Texture
Sheen
Texture
Taste and Aroma
Factors Affecting Taste and Aroma
Moistness
Factors Affecting Moistness
Cleanliness
Bread faults
Introduction
External faults
Faults in Volume
Lack of Volume
Excessive Volume
Faults in Crust
Lack of Crust Colour
Dark Crust Colour
Cracking of Crust
Leathery Crust
Hard Crust
Thick Crust
Blisters
Lack of Bloom
Shell Top
Irregularity of Shape
Lack of Cleanliness
Internal faults
Holes and Tunnels
Core, Seams, Streaks & Condensation Mark
Damp, Clamy & Closed Crumb
Dryness and Rapid Staling
Crumbliness of the Crumb
Defects in Taste and Aroma
Summary of bread faults and their causes
Bread diseases
Introduction
Rope
Bacteria Responsible
Symptoms
Sources of Contamination
Moulds
Types
Causes
Preventive Measures
Chemical Inhibitors
Germicidal Ultraviolet Rays
Recommended Bread Making Practices
Cleaning
Raw Material
Fermentation
Baking
Cooling
Contact Surface
Packing
Storage
Re-entry of State Bread
Customers
Bleeding Bread
Food Poisoning
Salmonella
Sources
Symptoms
Prevention
Streptococcus
Staphylococci
Variety bread
Introduction
French Bread
Italian Bread
Vienna Bread
Dutch Bread
Raisin Bread
Rye Bread
Egg Twist Bread
Cracked Bread
Process control
Fermentation
Proofing
Staleness in bread
Introduction
What is Staleness?
Characteristics of stale bread
Types
Crust Staling
Causes
Preventive Measures
Crumb Staling
Causes
Improper Quality Raw Material
Improper Bread Processing
Improper Packing and Storage
Retardation
Ingredients
Processing
Freezing
Use of Additives
Bake shop emergencies
Introduction
Yeast problem
Shortage of Yeast
No Yeast in the Dough
Too Much Yeast
Salt problem
Dough without Salt
Too Much Salt
Too Much Sugar, Shortening or Milk
Overweight of Flour or Water
Late Mixing

23. Other Fermented Products
Introduction
Bun goods
Raw Material
Processing
Prepared Mixtures
Pitza base/crust
Raw Material
Processing
Doughnut
Raw Material
Processing

24. Bread Ingredient
Introduction
25. Bread Making Methods
Introduction
Conventional methods
Straight Dough Method
Advantages and Disadvantages
Sponge and Dough Method
Advantages and Disadvantages
Salt Delayed Method
Advantages and Disadvantages
No Dough Time Method
Advantages and Disadvantages
Ferment and Dough Process
Mechanical dough development method
Liquid Brew

26. Bread Processing
Introduction
Ingredient selection and formula balancing
Mixing/Kneading
Purpose
Flying Ferment
Process
Importance
Other Preparation
Dough Temperature
Mixing Process
Hand Mixing
Machine Mixing
Slow speed mixing
High speed mixing
Spiral mixing
Mixing Stages
Mixing Time
Flour Quality
Bread Making Method
Dough Temperature and Consistency
Fat and Salt Quantity and Stage of its Addition
Over or Under Mixed Dough
Over Mixed Dough
Under Mixed Dough
Physical and Chemical Changes During Mixing
Physical Changes
Chemical Changes
Bulk fermentation
Physico-chemical Reactions
Under or Over Ferment Dough
Under Ferment Dough
Over Ferment Dough
Knock back
Dough make-up
Scaling
Rounding
Intermediate Proofing
Moulding
Hand Moulding
Machine Moulding
Panning
Tempering the Pan
Greasing/Glazing the Pan
Bread Pan
Proofing
Factor Affecting the Final Proof
Temperature
Relative Humidity
Diastetic Activity of the Flour
Fermentation
Under or Over Proofing
Over Proofing
Under Proofing
Baking
Time and Temperature
Physico-chemical Changes
Oven Rise and Oven Spring
Yeast Activity
Enzyme Activity
Starch Gelatinization
Protein Denaturation
Protein Coagulation
Browning Reaction
Oven Problems
Insufficient Oven Heat
Excessive Oven Heat
Excess Steam
Insufficient Steam
Improper Heat Distribution
Incorrect Pan Spacing
Depanning
Cooling
Slicing
Packing/Wrapping

27. Effluent Treatment
Introduction
Dissolved oxygen concentration as an indicator of water quality
Factory surveys
The strengths of fermentation effluents
Treatment and disposal of effluents
Disposal
Seas and Rivers
Lagoons
Spray Irrigation
Well Disposal
Disposal of Effluents to Sewers
Treatment processes
Physical Treatment
Chemical Treatment
Biological Treatment
Aerobic Processes
Tricking Filters
Towers
Rotating Discs
Rotating Drums
Activated Sludge
Anaerobic Treatment
Anaerobic Digestion
Anaerobic Filters
By-products
Distilleries
Breweries
Amino Acid Wastes

About NIIR

NIIR PROJECT CONSULTANCY SERVICES (NPCS) is a reliable name in the industrial world for offering integrated technical consultancy services. NPCS is manned by engineers, planners, specialists, financial experts, economic analysts and design specialists with extensive experience in the related industries.


NPCS also publishes varies process technology, technical, reference, self employment and startup books, directory, business and industry database, bankable detailed project report, market research report on various industries, small scale industry and profit making business. Besides being used by manufacturers, industrialists and entrepreneurs, our publications are also used by professionals including project engineers, information services bureau, consultants and project consultancy firms as one of the input in their research.