Futuristic Trends in

Biotechnology

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PREFACE

Biotechnology is one of the emerging fields that can add new and better application in a wide range of sectors like health care, service sector, agriculture, and processing industry to name some. This book will provide an excellent opportunity to focus on recent developments in the frontier areas of Biotechnology and establish new collaborations in these areas. The book will highlight multidisciplinary perspectives to interested biotechnologists, microbiologists, pharmaceutical experts, bioprocess engineers, agronomists, medical professionals, sustainability researchers and academicians. This technical publication will provide a platform for potential knowledge exhibition on recent trends, theories and practices in the field of Biotechnology. Aim of the research articles are invited in the following areas of interest, but not limited to

1. Bioprocessing Techniques
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3. Bioseparation
4. Bioreactors
5. Bioenergy
6. Recombinant DNA
7. Cell Fusion
8. Bioremediation
9. Biomarkers
10. Biofuels
11. Fermentation Technology
12. Applications with Technology Support
13. Clinical Engineering
14. Rehabilitation Engineering
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18. Instrumentation, Sensors, and Measurement
19. Bio-signal Processing
20. Biomedical Images and Signals
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22. Bioinformatics (including Genomics)

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CONTENTS

EVALUATION OF INDUSTRIAL FOOD FERMANTATION TECHNOLOGY

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I. INTRODUCTION

Fermented foods are staples of the human diet and have been produced and used up since the development of human civilizations. The process whereby microorganisms and their enzymes bring about these required changes in food materials is known as fermentation. Food fermentation methods can be categorized by the primary metabolites and microorganisms elaboratelactic acid bacteria (LAB) belonging to genera such as *Leuconostoc*, *Lactobacillus*, and *Streptococcus*. Fermentations can also be defined based on the food substrates, which include meats and fish, dairy, soybeans and other legumes, cereals, and grapes. Raw materials that contain more concentrations of monosaccharides and disaccharides, or in some cases starch, are fermented through lactic acid bacteria. Lactic acid bacteria (LAB) are a cluster of gram-positive, non-sporulating, anaerobic or facultative aerobic cocci or rods, fastidious on artificial media, but they grow gladly in most food substrates and lower the pH rapidly to a point where competing organism are not one longer able to grow, and it is one of the main fermentation products of the carbohydrates metabolism.

II. HISTORYOF FERMENTATION ARTAND SCIEN CE

Ancient Egyptians were the rst to ferment alcohol and vinegar from malt grains and fruits juices during the 1700s. However, they had no understanding of contamination in the fermentation process and the role of microorganisms in fermentation, and the use of specic equipment for production was not yet established (Gaden, 1982).

In the mid-eighteenth century, Louis Pasteur established the role of yeast in wine fermentation, and from then on a pure culture was used for quality wine, beer, and vinegar. During the same time, Carlsberg tried isolating single pure yeast cells for quality alcohol production. In the late eighteenth century and the early nineteenth century, use of an aerator for vinegar production was started. Vinegar fermentation also included a known volume of pasteurized, previously fermented vinegar as an initial substrate to prevent contamination and to serve as an inoculum. Hence, the process control of fermentation was initiated (Brinberg, 1953; Herrero, 1969). The importance of fermentation and production of different products gained attention in the beginning of the nineteenth century and continued through the middle of the nineteenth century. Several products were produced via fermentation, namely, glycerol, baker's yeast, lactic acid, and acetone butanol. Production of secondary metabolites via fermentation (such as antibiotics, amino acids, and vitamins) ourished during the late nineteenth century due to the need to treat soldiers ghting in World War II. Submerged fermentation with larger volumes under aerobic conditions with moderate process control was established during this period. In subsequent years, the fermentation industry has seen constant improvement with leaps and bounds on the production of high-value metabolites, including various antibiotics and growth hormones, using sophisticated bioreactors (Chiaoand Sun, 2007; Formenti et al., 2014; Humer and Schedle, 2016; Li et al., 2015; Liu et al., 2013; Motarjemi and Nout, 1996).

III. HISTORY OF FERMENTATION

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IV. FERMENTATION TECHNOLOGY

Micro-organisms, grown on a large scale, to produce valuable commercial products or to carry out important chemicaI transformations

V. FERMENTATION

Pasteur's "life without air", Latin word ***fervere, to boil***

Table 1: Some Important Fermentation Products

Product	**Organism**	**Use**
Ethanol	*Saccharomyces cerevisiae*	Industrial solvents, beverages
Glycerol	*Saccharomyces cerevisiae*	Productionofexplosives
Lacticacid	*Lactobacillus bulgaricus*	Food and pharmaceutical
Acetoneand butanol	*Clostridium acetobutylicum*	Solvents
α-amylase	*Bacillussubtilis*	Starchhydrolysis

VI. THE ROLE OF FERMENTATION TO FOOD

1. Flavor Enhancement

- Fermentation makes the food palatable by enhancing its aroma and flavor.
- These organoleptic properties make fermented food further popular than the unfermented one in terms of consumer acceptance.

2. **Nutritional Quality**

- A number of foods especially cereals are poor in nutritional value, and they constitute the main staple diet of the low-income populations. However, Lactic acid bacteria (LAB) fermentation has been shown to improve the nutritional value and digestibility of these foods. The acidic nature of the fermentation products enhances the activity of microbial enzymes at a temperature range of 22-25ºC.

- The enzymes, which include amylases, proteases, phytases and lipases, modify the primary food products through hydrolysis of polysaccharides, proteins, phytates and lipids respectively. Thus, in addition to enhancing the activity of enzymes, Lactic acid bacteria (LAB) fermentation also reduces the levels of anti-nutrients such as phytic acid and tannins in food leading to improved bioavailability of minerals such as iron, protein and simple sugars. The number of vitamins is also increased in the ferment.

3. **Preservative Properties**

- The preservative activity of Lactic acid bacteria (LAB) has been observed in some fermented products such as cereals, and yogurt.
- The lowering the pH to below 4 through acid production, inhibits the growth of pathogenic microorganisms which can cause food spoilage, food poisoning and disease. For example, Lactic acid bacteria (LAB) has antifungal activities. By doing this, the shelf life of fermented food is extended.

4. **Detoxification**

- Detoxification of mycotoxins in food through Lactic acid bacteria (LAB) fermentation has been demonstrated over the years.
- Using Lactic acid bacteria (LAB) fermentation for detoxification is more advantageous in that it is a minor method which preserves the nutritive value and flavor of purified food. In addition to this, Lactic acid bacteria (LAB) fermentation irreversibly degrades mycotoxins without leaving any toxic residues. The detoxifying effect is believed to be through toxin binding effect.

5. **Antibiotic Activities**

- Lactic acid bacteria (LAB) is applied as a hurdle against non-acid tolerant bacteria, which are ecologically eradicated from the medium due to their sensitivity to acidic environment.
- Also, fermentation has been demonstrated to be further effective in the removal of gram negative than the gram-positive bacteria, which are more resistant to fermentation processing.
- As such, fermented food can control diarrheal diseases in children. Moreover, Lactic acid bacteria (LAB)is also known to produce protein antimicrobial agents such as bacteriocins. Bacteriocins are peptides that elicit antimicrobial activity against food spoilage organisms and food borne pathogens but do not affect the producing organisms. Lactic acid bacteria (LAB) also synthesizes other anti-microbial compounds such as, hydrogen peroxide, reuterin, and reutericyclin.
- Other applications of Lactic acid bacteria (LAB) include their use as probiotics that restore the gut flora in patients suffering from diarrhea, following the usage of

antibiotics that destroy the normal flora.

VII. FERMENTATION TECHNIQUES

1. **Surface (solid state) techniques:** Microorganisms cultivated on the surface of a liquid or solid substrate. Complicated and rarely used in industry.

   Mushroom, bread, cocoa, tempeh

2. **Submersiontechniques:** Microorganisms aregrow in a liquid medium.

   Biomass, protein, antibiotics carried out by submersion processes.

VIII. REQUIREMENTS

1. **Pureculture:** organism, quantity, physiological state
2. **Sterilized medium:** for microorganism growth
3. **Seed fermenter:** inoculums to initiate process
4. **Production fermenter:** large model
5. **Equipment**
   - Drawing the culture medium
   - Cell separation
   - Collection of cell
   - product purification
   - Effluent treatment

IX. TYPES ON THE BASIS OF CULTURE

1. **Batchfermentation:** Sterile nutrient substrate, inoculated, grow until no more of the product is being made, "harvested" andcleaned out for another run.

   - **lagphase**(adapttotheirsurroundings)
   - **exponentialgrowth**(growinnumbers)
   - **stationaryphase**(stopgrowing)
   - **deathphase**

X. CONTINUOUS FERMANTATION

Substrate is added continuously to the fermenter, and biomass or products are continuously removed at the same rate. Under these conditions the cells remain in the Logarithmic phase of growth

XI. FED-BATCHFERMENTATION

Substrate increments as the fermentation progresses. Started as batch wise with a minor substrate concentration. Initial substrate is consumed, addition of fermentation medium

Table 2: Rangeoffermentation Technology

Microbialcell(Biomass)	Yeast
Microbialenzymes	Glucoseisomerase
Microbialmetabolites	PeniciIIin
Foodproducts	Cheese,yoghurt,vinegar
Vitamins	B12,riboflavin

Table 3: Examples of Foods and Food Additive Manufactured Using Industrial Fermantation Processes in Developing Countries.

FOODS	FOOD ADDITIVE MANUFACTURED
Alcoholic beverages	Wines, beer
Milk and milk products	Cultured milks, yogurts, cheeses
Flavors	Monosodium glutamate, nucleotides
Organic acids	Lactic acid, citric acid, acetic acid
Amino acids	Lysine, glutamic acid
Vitamins	Vitamins A, C and $B_{12,}$ riboflavin
Enzymes	Amylases, proteases, invertases

XII. FROM DESHPANDE AND SALUNKHE (2000).

Advantages

- Preserves and enriches food, improves digestibility, and enhances the taste and flavor of foods.
- Potential of enhancing food safety by governing the growth and multiplication of aamount of pathogens in foods.
- Important contribution to human nutrition particularity in developing countries, where economic problems pose a majorbarrierto ensuringfoodsafety.
- Low energy consumption due to the minor operating conditions relatively low capital and operating costs relatively simpletechnologies.
- Theycauseextremelyspecificandcontrolledchangestofoods by using enzymes.
- Preservationanddetoxificationofthefood.
- Wastetreatment.
- Healthassociatedproduct.

Table 4: Major Categories And Examples Of Fermanted Milk Products

Category	Typical examples
I. Lactic fermantations	
a. Mesophilic	Butter milk, Cultured buttermilk, Langofil, Tetmjolk, Ymer
b. Thermophilic	Yogurt, laban, zabadi, labneh, skyr, Bulgarian buttermilk
c. Therapeutic	Biogarde, Bifighurt, Acidophilus milk, yakult, Cultura-AB
II. Yeast – lactic fermantations	Kefir, koumiss, acidophilus – yeast milk
III. Mold – lactic fermantation	Viili

Source : Table 4 p. 58. In B. A. Law, editor, 1997. *Microbiology and Biochemistry of cheese and fermented milk, New York: Chapman and Hall.*

Disadvantages

- Hazardous microbial contamination alwaysexistin fermented food.
- The irregular distribution of salt in lactic acidfermented fish products and contamination of *Aspergillusflavus* in traditional startercultures forrice wine and soybean sauce resultin severefoodpoisoning occurrences.
- Health(obesity,cancer)
  C.H. LEE, 1989

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