// Education is a ladder to gather fruits of knowledge //

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Fermentation Technology

Department of Microbiology

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2	1.1 Microbial Growth
3	2. Fermentation Process
4	3.Apllication of Fermentation technology
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1)INTRODUCTION:-

Fermentation word is derived from Latin verb "fervere" which means to boil. This technology has been perceived in different sense by the world of microbiologist and biochemist. For biochemists, "fermentation is a catabolic process leading to generation of energy". Whereas, according to industrial microbiologist, "fermentation is the process of mass cultivation of micro-organisms that convert substrates into valuable products through aerobic or anaerobic route". A general outline of the process is outlined in figure 1. Fermentation technology has wide application for the production of products such as organic solvents (acetone, alcohols), fermented beverages (wine, beer, whisky), and other products like enzymes, amino acids, vitamins, pharmaceuticals etc. The fermentation processes is dependent on microbial growth, which in turn is governed by many biochemical and physical parameters. The motive of all parameters is to provide the most suitable environment for the growth of micro-organisms. This chapter is dedicated to discuss

the growth characteristics of micro-organisms, the types and needs of fermentation process and their applications.

1.1Microbial Growth:-

The most important criterion of a fermentation process is to achieve good yield of product which in turn is dependent on the proper microbial growth. The micro-organism require Environmental Sciences Environmental Microbiology & Biotechnology Module 21: Fermentation Technology optimum pH, temperature, oxygen, minerals, energy source and other raw material conditions to complete their life cycle under six phases as illustrated in figure 2 and discussed below. a) Lag phase is the no microbial growth phase, also known as acclimatization period, when the newly inoculated micro-organism adapt to their new environment and hence show no increase in number. b) Acceleration phase: is the period when microbes start increasing in number c) Log phase: is the period when microbes demonstrated exponential increase in their number and utilizes most of the raw materials for their growth. d) Stationary phase is the static stage when microbes does not show any change in their number and their growth arrest at this point, probably due to the depletion of energy sources in the media, constraints of space and accumulation of toxic end products. e) Death phase is the time where microbes show steady decline in their number due to loss of ability to reproduce and indicate the climax of their growth period. All these phases of microbial life illustrate a sigmoidal curve, and depending upon the type of product particular phase is considered for their harvest. For example, the processes where cell biomass is required, microbes are harvested after exponential growth. Whereas, when secondary metabolites are the major products, harvest is done after their production in stationary phase.

1. The microbial growth in a batch fermentation system where one time addition of microbial culture and sterilized media components is done. It is a closed system, where no further addition or removal of materials are followed until the all the stages of microbial life cycle are completed and product is formed. After completion, the product is removed and processed under various downstream processes. Another type of fermentation process is fed-batch, where nutrients are fed more than one times during microbial cultivation, but products are harvested only at the end of the process. This method provides opportunity to control the yield and productivity of the process by adding limiting nutrients at defined phase of cell growth. For example the substrates such as ethanol, methanol or acetic acid may be added at the later stages of cell growth to avoid their inhibitory effect at initial growth phase. The most valuable method for high turnover of industrial products is the continuous fermentation that allows continuous supply of nutrients and raw materials. To maintain a static environment

inside the vessel, products are also harvested continuously from the overflow of fermenter. The exponential growth of microbes is maintained for a prolonged period which is suitable for production of primary metabolites such as organic acids, amino acids, single cell protein etc.

2)Fermentation Process :-

Initially, Louis Pasteur described fermentation as "an anaerobic process carried out by yeast like organism to break complex sugars in simpler ones". But, now fermentation includes anaerobic as well as aerobic processes that need maintenance of oxygen deficient or supplemented aseptic conditions. In case of anaerobic fermentation, no aeration device is needed as the gases generated during the process enable satisfactory mixing. The environment inside the vessel needs to be maintained oxygen scarce during the whole process which is maintained by flushing a mixture of CO2, H2 and N2 in the head space of the fermenter. On the other hand, large volumes of oxygen approximately 60 times the medium volume are required for aerobic fermentation processes. Such fermenters need provision of efficient aeration and uniform mixing of fermenter contents. To accomplish sterilized conditions along with uniform distribution of media, air, pressure and timely escape of products, a special vessel known as Fermenter is employed.

3)Fermentation Techniques

Solid State Fermentation	Submerged Fermentation
Microorganisms are cultivated on the surface of a liquid or solid substrate.	Microorganisms grow in a liquid medium.
Complicated and rarely used in industry.	Simple and used in routine..
Used in Production of Mushroom, Bread, Cocoa and temph etc	Protein, Biomass, antibiotics, enzymes and sewage treatment are carried out by submerged fermentation.

4) Application of Fermentation Technology

Advances in fermenter designing and fermentation technology have led to the commercialization of a number of fermented products. Various kinds of food and food

Fermentation Technology additives are manufactured using industrial fermentation technology in developing countries. Wild type and recombinant microorganisms are used in the production of following products.

1. Alcoholic beverages Whisky, rum, brandy, Beer and wine
2. Milk and Milk Products Cultured milks, yoghurt, cheese
3. Microbial flavors Vanillin, benzaldehyde and lactones
4. Biofuels Ethanol, acetone-butanol
5. Microbial polysaccharides Dextran, xanthan gum and pullulan
6. Food additives and ingredients L-glutamic acid and L-aspartic acid
7. Vitamins Vitamin A, C, B12, and riboflavin
8. Enzyme Amylase, invertase, Protease

5) Advantages of Fermentation Technology

1. Preservation and enriches food, improves digestibility, and enhances the taste and flavors of foods. 2. Potential of enhancing food safety by controlling the growth and multiplication of number of pathogens in foods.

3. Important contribution to human nutrition, particularly in developing countries, where economic problems pose a major barrier to ensuring food safety.

4. Low energy consumption due to the mild operating conditions relatively low capital and operating costs relative simple technologies.

5. They cause specific and controlled changes to foods by using enzymes.

6. Preservation and detoxification of the food.

7. Waste treatment. 8. Health related product. Environmental Sciences Environmental Microbiology & Biotechnology Module

6) Disadvantages of Fermentation

1Hazardous contamination always exists in fermented food.

2The uneven distribution of salt in lactic acid fermentation fish products and contamination of Aspergillus flavus in traditional starter culture for rice wine and soyabean sauce result in severe food poisoning incidences.

3Health (obesity).

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