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ALKALOPHILES AND INDUSTRIAL ENZYMES

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Abstract - *Alkalophiles are alkali-loving microbes They are a class of extremophiles microbes that can survive in alkaline conditions. The cell wall of these plays significant role in maintain the intracellular pH value in between the range .Alkalophilc enzymes have a great impact in the Biotechnology Industry .The alkaline enzymes like protease, cellulose, Xylanase plays a key role in Biological detergents, pulp, paper industry etc, This paper discusses Alkalophiles Industrial applications and use of these enzymes have reduced the production costs and have a wide applications in food stuffs, chemicals and Pharmaceuticals .*

Key Words: **Alkalophiles, Enzymes, Food Industry, Protease, Xylanse, Amylase**

1. INTRODUCTION

Alkalophiles are organisms that have their optimum growth rate at least two pH units above neutrality. They require alkaline media for growth. Alkaliphiles belongs to extremophiles and can survive in alkaline environments. The Alkalophiles are classified into two classes i.e Alkalophiles which requires alkaline pH of 9 or more for their growth and have an optimal growth pH of around 10 and Haloalkalophiles which require both an alkaline pH (pH 9) and high salinity (up to 33% [wt/vol] NaCl). Alkalophiles have been isolated mainly from neutral environments, sometimes even from acidic soil samples and feces. Haloalkaliphiles have been mainly found in extremely alkaline saline environments, such as the Rift Valley lakes of East Africa and the western soda lakes of the United States.

1.1 Aerobic Alkalophiles:-

These organisms can grow in neutrophilic conditions and can also occupy specific extreme environments in nature. To isolate these kind of microorganisms the medium used should be alkaline and its pH should be adjusted to 10 The studies showed that frequency of these in soil samples is 102 to 105CFU/ml of soil of the population of the neutrophilic microorganisms [6].Some of the studies showed that alkalophilic bacteria have also been found in deep-sea sediments collected from depths up to the 10,898 m of the Mariana Trench [21]

1.2 Anaerobic Alkalophiles:-

These have isolated and characterized a range of thermophilic anaerobic alkaliphiles [2]. Anaerobic alkalophiles were firstly reported [16] but taxonomic details were not discussed. Many anaerobic spore-forming alkalophiles were isolated by conventional procedures and few applications have been studied.

1. PHYSIOLOGICAL FEATURES

Alkalophiles belongs to a class of extremophiles microbes and have the capability to survive under alkaline pH and can grow optimally around a pH of 10.The growth of the microbes in alkaline conditions have some complexities in biochemical activities as it can lead to denaturation of DNA , it can lead to instable plasma membrane , inactivation of cytosolic enzymes and to overcome such hurdles they must be having specific cellular machinery or they must have some method of acidifying the cytosol in relation to extracellular environment and it has been discovered that alkaliphiles have some enymes that functions efficiently near pH ranges and can survive in intensely basic environments. Alkalophiles maintains cytosolic acidification through passive and active means.

1. ALKALINE ENZYMES AND THEIR APPLICATIONS

Studies of Alkalophiles have led to the discovery of many new types of enzymes that exhibit interesting properties. The first Alkaline enzyme was protease .Alkaliphiles have very useful applications in the field of biotechnology as it posses method of regulating pH and producing ATP .Alkalophile enzymes from aerobic and

anaerobic alkaliphilic bacteria tend, as expected, to have activity profiles that included higher pH values than displayed by mesophile enzymes. Some of the industrial applications of these enzymes are discussed in the table no.1

Enzymes	Strains	Industrial Application	Temp	pH	Ref
Protease It catalyses the hydrolysis of certain peptide bonds in the protein molecules. It attacks by two modes : Exoprotease and Endo protease	*Saccharomonospora virdis* SJ-21	Detergents Pharmaceuticals	70°C	9	[9]
	Nocardiopsis prasina HA-4	Leather Industry	55°C	7-10	[17]
Amylase It catalyze the degradation of starch and hydrolyze starch in endo fashion cleaving glycosidic bonds in amylase and amylopectin	*Thermomonospora Virdis* TF-35	Detergent, Baking	60 °C	6	[22]
	Thermomonospora curvata	Textile Industry	65°C	5.5-6	[5]
Xylanase These are complexed with cellulose and pectin and are bound to lignin.It is likely that xylan molecules covalently link with lignin and interact with polysaccharide	*Thermomonospora fusca*	Paper ,Pulp Baking	60°C	7	[15]
	Kocuria sp.RM1	Animal feed	30°-85°C	4.5-9	[11]
Dextranase It effectively degrade dextran matter in sugarcane converting them to glucose	*Streptomyces* sp.NK458	Sugar mills	60°C	9	[18]
Lipase These are indispensable for bioconversion of lipids	*Candida sp*	Food industry	50°C	8.5	[1]

Table No.1 Some of the Industrial application of Alkalophiles

There are several interesting properties of these enzymes. **Protease**:-It was reported first time by Horikoshi in 1997from Bacillus sp. Strain 221. It has a wide application in Detergents industry, it is widely used in Dehairing process, where dehairing is done at a pH of 8-10.Another important application of this enzyme is in the use of an alkaline protease to decompose the gelatinous coating of X-ray film **Xylanase**:- Xylan is the most abundant non-cellulosic polysaccharide present in hardwoods and annual plants. These useful in facilitating the bleaching of kraft pulp as they increased the extractability,they also forms a barrier against effective reduction in kappa particles number and increases the pulp brightness. **Amylase**:- This enzyme degrades starch in to shorter polymeric fragments and yield glucose, maltose useful for the industry. **Lipase**:-These are indispensable for the conversion of lipids from one organism to another and they have a tremendous potential in areas such as food technology, biomedical sciences, it is used as biosensors and in detergents also in combinations with proteases and cellulases as it splits fats. **Cellulase** :- It is a polymer of glucose monomer joined by beta 1-4 bonds It is used to modify the surface and properties of cellulosic fibres and fabrics and has a wide application in stone-washing, filteration of beer. **Pectinase**: The pectins are homo or heteropolysacchrides mainly of galacturonic acid. It is used in the industry to separate fibres and eliminate pectin in jute, flax.

2. CONCLUSION

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The Alkalophiles possess additional capacities, e.g., some with high temperature optima and others with low temperature optima that increased the range of environments in which they were catalytically competent [12,3,7].They have a wide range of applications in industry like proteases, which are used as detergent additives and for removing hair from hides; starch-degrading amylases with elevated pH optima are also suitable for laundry use and debranching enzymes, together with amylase, play a role in stain removal [8,4,20]; alkaline keratinases can degrade feathers [10]; and cyclomaltodextrin glucanotransferases (CGTases) from alkaliphilic strains enhance the production of cyclodextrins (CDs), which are used in pharmaceuticals, foodstuffs, and for chemical interactions [19].They also produce useful metabolites like carotenoids [6].

In Biotechnology industry alkaliphiles are used as microbial fuel cells (MFCs) in devices [14]. In which bacteria oxidize organic or inorganic substrates and generate current. As electrons are produced during the oxidation reactions, they are transferred to the anode, the negative terminal. They then flow to the cathode, the positive terminal, via conductive material whose properties support conditions for producing electricity. MFC is a psychrophilic alkaliphile from seawater, *Pseudomonas alcaliphila* MBR [23], which releases phenazine-1-carboxylic acid under alkaline conditions [24]. Another alkaliphile has been used to generate "bioelectricity" in an MFC. It is *Corynebacterium* sp. strain MFC03, which uses organic compounds and it

depends on redox compounds that are excreted into the medium [13]. The Alaklophilic enzymes have additional uses in various fields of industry and promises several interesting uses for biotechnology research with a view of regulating the pH and ATP production.

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