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Production of lipase from *Streptomyces*

Abstract

Lipases constitute an important group of biocatalysts for biotechnological applications. This enzyme can be produced by plants, animals, and microorganisms. However, microbial lipases are the most studied and occupy the center attraction because of their stability, selectivity, and broad substrate specificity. Streptomyces are filamentous Gram-positive bacteria found generally in the soil. This microorganism is known mainly for their capacity to synthesize of numerous antibiotics and other secondary metabolites. They also produce a large number of enzymes such as lipases, which makes Streptomyces a genus with significant biotechnological potential.

Keywords: lipase activity, lipase production, *Streptomyces*, biotechnology

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Introduction

Enzymes are considered as nature's catalysts and the most enzymes are produced by the fermentation of bio based material. Lipases are unique in catalyzing the hydrolysis of fats into fatty acids and glycerol at the water-lipid interface and reversing the reaction in non-aqueous media. Lipolytic enzymes are involved in the breakdown and thus in the mobilization of lipids within the cells of individual organisms as well as in the transfer of lipids from one organism to another.[1]

Lipases are ubiquitous in nature and are produced by several plants, animals, and microorganisms. Lipases of microbial origin represent the most widely used class of enzymes in biotechnological applications and organic chemistry.[2] Lipases have emerged as one of the leading biocatalysts with proven potential for contributing to the multibillion-dollar underexploited lipid technology bio-industry and have been used in situ lipid metabolism and ex-situ multifaceted industrial applications.[3] Lipases are generally produced on lipidic carbon, such as oils, fatty acids, glycerol or tweens in the presence of an organic nitrogen source.[4]

Many microorganisms are known as potential producers of extracellular lipases, including bacteria, yeast, and fungi. Fungal species are preferably cultivated in solid-state fermentation, while bacteria and yeast are cultivated in submerged fermentation.[5] Among several lipases reported from wide varieties of sources, microbial lipases occupy the central attraction regarding their broad biotechnological applications. Microbial lipases constitute an important group of biotechnologically valuable enzymes, mainly because of the versatility of their applied properties and ease of mass production. Microbial lipases are widely diversified in their enzymatic properties and substrate specificity, which make them very attractive for industrial applications.[1,6]

Lipase production and activity in Streptomyces

The genus *Streptomyces* (phylum: *Actinobacteria*) are Gram-positive bacteria, high G+C (70%) genome content, soil-living bacteria with characterized branching filamentous morphology. *Streptomyces* sp. has a great potential in producing a diverse range of secondary metabolites including antibiotics, antitumor agents, antiparasitic, immunosuppressive agents, and a large number of extracellular enzymes which are essential to the degradation of biomass to assimilable carbon moieties. Generally, these enzymes are hydrolases such as cellulases, xylanases, ligninases, amylases, lipases, nucleases etc. Therefore, *Streptomyces* is widely recognized as an industrially important microorganism.[7,8]

Cho et al.[6] isolated from the soil a newly *Streptomyces* strain, called *Streptomyces* sp. CS326. To produce lipase, the strain was cultured at 28°C for 168h on a rotary shaker maintained at 180 rev min^{-1}. The culture medium (1 L) was supplemented with 10g glucose, 10g soybean, 0.1g Na_2HPO_4 and distilled water. The author found an extracellular lipase and this enzyme was purified using a single step gel permeation chromatography on Sepharose CL-6B. The molecular weight of this lipase was estimated to be 17,000 Da by SDS-PAGE. The activity was optimum at 40°C and pH 7.0 and was stable at pH 5.0–8.0 and below 50°C and the substrate preferred was p-nitrophenyl palmitate (C16).

Streptomyces sp. TEM 33 strain was isolated from soil by Cadirci et al.[9] The lipase production was performed by Solid State Fermentation (SSF) and the activity was measured 1.74±0.0005U/gram dry substrate (gds) by pNPP method on the 6th day of fermentation with 71.43% final substrate moisture content. According to the authors, the advantage of SSF is that this media is similar to the natural habitat. In addition, in industrial process SSF offers distinct advantages over

submerged fermentation including economy of the space needed for fermentation; simplicity of the fermentation media; no requirement for complex machinery, equipments and control systems; greater compactness of the fermentation vessel owing to a lower water volume; greater product yields; reduced energy demand; lower capital and recurring expenditures in industry; easier scale up processes; lesser volume of solvent needed for product recovery; superior yields; absence of foam build-up and easier control of contamination due to the low moisture level in the system.

Mishra & Gupta[10] isolated 105 *Streptomyces* from different samples (water, soil, and plants), after screened for lipase production, the *S. halstedii* strain ST 40 exhibited higher activity. The authors used nine different types of substrates viz., Tween 20, 40, 60 and 80, mustard oil, sunflower oil, soya bean oil, ghee and olive oil were as inducers substrate into the medium. The results showed that the substrate Tween 20 showed the highest enzyme activity i.e. 1.6 IU/ml at 4h of incubation.

Vishnupriya et al.[11] studied the lipase production from *Streptomyces griseus* using olive oil, palm oil, and sunflower oil as substrates. The production of lipase was performed in orbital shaker 96hrs and the production was optimum at 72h of incubation by using olive oil as a substrate and the enzyme activity was found to be 117.88U/ml. On the other hand, using sunflower oil and palm oil the maximum production was obtained at 24h and 48hours of the incubation period and their enzyme activity were 51.90 and 51.90U/ml respectively.

Dos Santos et al.[12] evaluated a wild-type *Streptomyces clavuligerus* strain in submerged fermentation using an orbital shaker. After 36h of fermentation, the lipase hydrolytic activity was 3000UL^{-1}, measured at pH 9.0 and 37°C by using p- nitrophenyl palmitate (pNPP) as substrate. In another study with *S. clavuligerus*, Vasconcelos et al.[13] compared the extracellular lipase enzymatic activity by spectrophotometry using pNPP as substrate between wild-type and mutant MMS 150 strain, using the complex culture medium proposed by.[14] When cultivated in complex medium, the mutant strain presented less lipolytic activity in comparison with the wild-type. However, when cultivated in the modified complex medium (lacking glycerol), mutant strain showed a lipase production about 2.4 times higher than that of the wild-type. These results show that the mutation caused a greater lipolytic activity depending on the composition of the culture medium.

Conclusion

Microbial lipases have a great biotechnological potential, ranging from the use of laundry detergents to stereospecific biocatalysts. The genus *Streptomyces* represents an extremely versatile group of bacterial extracellular enzymes that are capable of performing a variety of important reactions, thereby presenting a captivating field for future studies. Although studies have been growing in this sense, much research is still necessary to determine the full extent of lipase production and activity with genus *Streptomyces*.

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Conflict of interest

There is no conflicts to publish the article in this Journal.

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