Bioprocess design for improving the quantity and quality of alginate and poly-β-hydroxybutyrate (PHB) by *Azotobacter vinelandii*

Carlos Peña (1), Tania Castillo (1), Cinthia Núñez (2) and Daniel Segura (2)

(1)Departamentos de Ingeniería Celular y Biocatálisis y (2) Microbiología Molecular, Instituto de Biotecnología UNAM, Universidad Nacional Autónoma de México (1), Ave. Universidad 2001, Col. Chamilpa, Cuernavaca, 62210, Morelos, México. carlosf@ibt.unam.mx

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Introduction. *Azotobacter vinelandii* produces two polymers of biotechnological interest; the alginate, an extracellular polysaccharide, and the poly-β-hydroxybutyrate (PHB) an intracellular polyester [1]. Alginates present a wide range of applications, acting for example as stabilizing, thickening, gel or film-forming agents, in various industrial fields. More recently, it has been proposed their use as a source of soluble fiber, or in medical products. PHBs have been drawing attention because they are biodegradable and biocompatible thermoplastics, which can be processed to create a wide variety of consumer products, including plastics, films, and fibers [2]. Recently and based in their properties of biocompatibility and biodegradability, new attractive applications for PHBs have been proposed in the medicine field, where the chemical composition and product purity are critical [2].

Subjects covered by this study include; research concerning the production of alginate and PHB by *A. vinelandii,* particularly aspects which include the molecular regulation of the production of the two polymers, as well as the influence of fermentation parameters, which determine the production and composition of alginate and PHB.

Results. Several studies have been reported for the alginate production by *A. vinelandii*, either in batch or continuous cultures. It has been shown that dissolved oxygen tension and the bacterial specific growth rate play a key role in defining the molecular weight distribution [3]. In addition, the manipulation of culture broth components influences the acetylation degree of the polymer [4]. This knowledge opens up many possibilities for designing processes to produce tailor-made alginates. In the case of the PHB, much effort has been made to reduce the production cost by the development of genetically improved strains, using low-cost raw material and developing more efficient fermentation processes.

In this line, the implementation of multistage fermentation processes or fed-batch cultures has made possible to improve the yield and productivity of PHB, reaching a concentration of 30 g L^{-1} (in a 2.5 L fermentor) and also notably improving productivity up to 1.05 g L^{-1} h^{-1}. On the other hand, the manipulation of the molecular weight of PHB by means of the use mutant strains of *A. vinelandii* (OPN), together with the control of the aeration conditions of the culture, could be a suitable strategy to produce PHB with improved properties, expanding the potential application of this polymer [5].

Conclusions. Overall, the development of new fermentation strategies has shown promising results in terms of improving productivity of alginate and PHB, and modifying the molecular characteristics of both polymers. The understanding of the regulatory mechanisms involved in the control of the synthesis of alginate and PHB and of their metabolic relationships has increased considerably, making way for new potential strategies to further improve their production.

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