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Major Problems Addressed in Pullulan Production; A Review

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Abstract

Pullulan is the one of the most potent bio-compatible polymer which is basically synthesized by the *Aureobasidium pullulans.* This polymer appears to be a linear α-glucan of maltotriose units with occasional branching of glucosyl or maltosyl substitution. The microbial pullulan can able to make a thin film which is oil resistant, transparent, odourless, colourless, tenacious, and impermeable to oxygen. The pullulan shows its resistance to the mammalian amylases, hence, it provides fewer calories and can be treated as dietary fibre. The solutions of the pullulan are of comparatively of very low viscosity, low consistency that resembles the Arabic gum. The pullulan was used safely as a pharmaceutical bulking agent and food ingredient in Japan before 25 years back. It has the capacity to form excellent films that are having heat sealable with oxygen barrier property. In this present review, the problems faced in pullulan production is highlighted.

Keywords: Pullulan; *Aureobasidium pullulans;* α-glucan; Fermentation; Melanin

Introduction

A few numbers of fungal based α-glucans have been reported which are exopolysaccharide (EPS) in nature. Pullulan is one of the most useful α-glucan produced by the polymorphic yeast like fungus *Aureobasidium pullulans* [1]. The pullulan production is an aerobic process. Therefore, it is essential to supply oxygen to the liquid medium during production of pullulan. For better yield, the maintenance of the culture morphology and conditions are required during the fermentation process [2]. The adjustment of initial pH value in the medium during the fermentation process helps to maintain the morphology of the organism required for better production. However, the information obtained from the reported literatures regarding the pullulan production are confusing and in some cases contradictory due to involvement of various factors regulating the biosynthesis of pullulan [3-5].

Cost of Raw Materials

The cost of raw materials required for the production of pullulan is very high, which directly affects the cost of pullulan. It was reported that, the cost of pullulan is three times higher than the other polysaccharides [2]. However, the cost of the raw materials required for pullulan production accounts 30% of the total production costs [5]. Moreover, lower productivity of the microbial strains used for the pullulan production along with the lesser yield of the final product after purification also increases its cost. Hence it is important to select a potential strain for the pullulan production. One of the major problems related to production of pullulan is that, some of the used strains are not able to tolerate the higher concentration of glucose or other carbon sources [6]. Therefore, it is very necessary to screen the osmotolerant organism for the pullulan production. Now-a-days so many researchers have tried to enhance the yield and productivity of pullulan from the selected microorganisms by examining the effect of media components, temperature, metal ion concentration and pH [7-9].

Higher Viscosity of Culture Broth

The problems that have been faced during production of pullulan are higher viscosity of the broth, production of melanin pigment along with pullulan and degradation of pullulan (pullulanolysis) during the course of fermentation. Moreover, after the fermentation, the extracellular metabolites, residual media components, microbial cells and cellular debris are left in the fermentation medium. Hence, alternative downstream processing is necessary to separate these impurities before the precipitation of pullulan [10].

Production of Melanin

The melanin pigments are synthesized in the pentaketide pathway (both intracellularly as well as extracellularly) along with the pullulan production. The melanin synthesis depends upon the culture conditions and media compositions [11]. For melanin separation activated charcoal is used. But, the major drawback with the activated charcoal is that, some amount of pullulan is lost along with fine powders of the activated charcoal due to contamination. Additionally, the use of activated charcoal increases the viscosity of the broth. Hence, it is required to search for the alternative method for the separation of melanin pigments.

Lack of Effective Downstream Process

Suitable organic solvent is required for the accomplishment of the one step precipitation process of pullulan in the culture supernatant after the biomass separation. Generally, the solvent having slightly higher hydrophillicity and lower molecular weight are not suitable for the precipitation process. Therefore, the screening of appropriate organic solvent for the precipitation of pullulan is a key step in the pullulan production [12,13].

Optimization of Process Parameters

The single point optimization study and statistical design were used in order to enhance the pullulan production. The major drawbacks that have been found in all these cases are the use of expensive media components like yeast extract, peptone and sucrose for pullulan production. Therefore, it is important to replace these costly nutrients by low cost substrate [14].

Conclusion

Currently, various researches are going on in order to produce higher yield, short fermentation time, low cost, and high purity of the pullulan. Introduction of mutagenic strains for pullulan production and manipulation of metabolic engineering can fill the gap.

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