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A REVIEW ON PRODUCTION OF ALGINATE AND BIOSURFACTANT FROM EXOPOLYSACCHARIDE FORMED BY PSEUDOMONAS AERUGINOSA

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ABSTRACT:
Pseudomonas species are renowned for their ability to produce diverse extracellular polymeric substances, including exopolysaccharides (EPS) with significant biotechnological potential. This research focuses on harnessing the EPS produced by *Pseudomonas aeruginosa* to extract valuable bioproducts: biosurfactant and alginate. This study aims to optimize the production of EPS by these *Pseudomonas* strains through controlled fermentation conditions. Subsequently, the extracted EPS is subjected to purification techniques to isolate and identify biosurfactant and alginate components. The functional properties of the isolated bioproducts are assessed to evaluate their potential applications. Biosurfactants, amphiphilic molecules, possess remarkable surface-active properties, finding applications are found across diverse industries, including environmental remediation, food production, and pharmaceuticals. Alginate, a linear copolymer of mannuronic acid and guluronic acid, exhibits excellent gelling and film-forming properties, making it valuable in food, pharmaceutical, and biomedical fields. By exploring the biotechnological potential of *Pseudomonas*-derived EPS, this research contributes to the advancement of sustainable and environmentally friendly alternatives to conventional chemical surfactants and polymers. The study focuses on optimizing the production of these valuable compounds by exploring different culture conditions and extraction methods. Additionally, the chemical characterization of the extracted biosurfactants and alginate are conducted to assess their properties and potential applications. This research aims to advance sustainable and eco-friendly methods for producing biosurfactants and alginate, offering potential benefits across various industries.

Keywords: - EPS, exopolysaccharide, pseudomonas, alginate, biosurfactant, aeruginosa, putida.

INTRODUCTION :

Exopolysaccharides (EPS) are bacterial polysaccharides synthesised and secreted by various microorganisms into the extracellular environment. These substances can be either soluble or insoluble polymers. The composition, functions, and chemical and physical properties of EPS can vary significantly from one bacterium to another, influencing their primary conformation. EPS are mostly carbohydrates, and some non-carbohydrate substituents. (Ates, 2015)

EPS, composed of polysaccharides, proteins, and lipids, play crucial roles in bacterial survival, biofilm formation, and interaction with the environment. Among the various EPS produced by these microorganisms, exopolysaccharides (EPS) stand out as a promising source of valuable biomolecules. EPS are large, high-molecular-weight polymers that bacteria secrete into their surrounding environment. Microbial produced biopolymers are mostly used in biopharmaceuticals, biomedical and food industry like alginate (Zhao, 2018). Microbial polymers are recognized as valuable sources of polymeric materials with significant commercial potential. Their diverse structures and unique properties allow for a wide range of applications and easy modifications. Additionally, bacteria can form biofilms on various surfaces, which have been shown to protect microbial communities from environmental stresses (Vidhyalakshmi, 2017). Most of the EPS producing bacteria

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are homo or heteropolysaccharide producers. *Pseudomonas* spp. can produce two different polysaccharides. Exopolysacchaides (EPS) provide self-protection for cells against desiccation, predation, antibiotics, and antimicrobial substances. Additionally, EPS facilitates bacterial aggregation, surface attachment, and symbiosis between plants and microbes. EPS secretion can occur in the presence of a lipid acceptor molecule in the synthase-dependent pathway, which completes polymer strands across the membrane and cell wall (Ates, 2015).

Pseudomonas aeruginosa and *Pseudomonas putida* are well-known bacterial species with the ability to produce diverse exopolysaccharides (EPS). These extracellular polymeric substances play crucial roles in various biological processes, including biofilm formation, nutrient acquisition, and stress response. Among the EPS produced by these bacteria, biosurfactants and alginate have received significant attention because of their potential applications in various industries. Biosurfactants are surface-active compounds that can reduce surface and interfacial tensions. They display a variety of properties, such as emulsification, foaming, and cleaning ability. These properties make them valuable in various applications such as bioremediation, food processing, and cosmetics. Alginate, on the other hand, is a linear polysaccharide made up of mannuronic acid and guluronic acid residues. It has excellent properties for film-formation, water retention, and gelling properties, making it useful in the food, pharmaceutical, and textile industries. The microbial production of biosurfactants and alginate provides sustainability, biodegradability, and a lower environmental impact compared to chemical synthesis. Enhancing the yield and quality of valuable biomolecules is possible by optimizing the production process and exploring various culture conditions. This study investigates the production of biosurfactants and alginate from EPS derived from *Pseudomonas aeruginosa* and *Pseudomonas putida.* By characterizing the compounds produced and exploring their potential applications, this research aims to contribute to the development of sustainable and eco-friendly processes for the producing these valuable biomolecules.

REVIEW OF LITERATURE:

Meena S, Vidhya Kalaivani M, Abhishek Dutt Tripathi, Ramyaa Lakshmi TS (2020) studied on Optimization and characterization of Alginic acid synthesised from a novel strain of *Pseudomonas stutzeri*. Alginate is in high demand for biomedical, pharmaceutical and bioengineering applications. This study focuses on isolating strains of *Pseudomonas stutzeri* that demonstrate the potential for alginate synthesis. Additionally, the study examines the application of alginate for the removal of heavy metals.

R. Vidhyalakshmi, C. Valli Nachiyar, G. Narendra Kumar, Swetha Sunkar, Iffath Badsha (2018) studied on production, characterization and emulsifying property of exopolysaccharide produced by marine isolate of *Pseudomonas fluorescens*. Emulsification activity was found to be similar in hydrocarbons with fatty acids compared to hydrocarbons without fatty acids. This capability qualifies *P. fluorescens* as a potential candidate for bioremediation processes, and the EPS

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produced can serve as a substitute for synthetic emulsifiers.

Viviana Urtuvia, Nataly Maturana, Fernando Acevedo, Carlos Pena (2017) studied on Bacterial alginate production: an overview of its biosynthesis and potential industrial production. The composition of alginate monomers and their molecular weight significantly affects their properties. Different alginates with varying molecular weights and consistent physiochemical characteristics can be produced by manipulating the culture conditions during fermentation.

Ozlem Ates (2015) studied on Systems biology of microbial exopolysaccharides production. Exopolysaccharides produced by a diverse group of microbial systems are rapidly gaining recognition as important industrial biomaterials. These compounds possess unique and complex chemical structures, along with interesting physiochemical and rheological properties that offer novel functionalities. As a result, microbial EPS find wide range of commercial applications across various sectors, including food, feed, packaging, textile, cosmetics, pharmaceuticals, agriculture and medicine.

Kamila Myszka, Katarzyna Czaczyk (2009) studied on characterisation of adhesive exopolysaccharide produced by *Pseudomonas aeruginosa* under starvation condition. *Pseudomonas aeruginosa* produces significant amounts of exopolysaccharide, making it an ideal model organism for the studying EPS-mediated adhesion. This investigation aimed to assess how limited nutrient availability in the culture medium affects the composition of EPS produced by *P. aeruginosa*.

Filomena Freitas, Vitor D. Alves, Joana Pais, Nuno Costa, Cristina Oliveira, Luis Mafra, Loic Hilliou, Rui Oliveira, Maria A. M. Reis (2009) studied on characterization of an extracellular polysaccharide produced by a *Pseudomonas* strain grown on glycerol. A new extracellular charged polysaccharide, primarily composed of galactose with smaller amounts of mannose, glucose and rhamnose, was produced through the cultivation of *Pseudomonas oleovorans* NRRL B-14682 using glycerol as the sole carbon source. The study also demonstrates that this exopolysaccharide exhibits excellent flocculating and emulsifying properties, as well as film-forming capabilities. These characteristics make this polymer a viable alternative to more expensive natural polysaccharides for various applications in the food, pharmaceutical, cosmetic, textile, paper and petroleum industries.

RESULTS :

Meena S, Vidhya Kalaivani M, Abhishek Dutt Tripathi, Ramyaa Lakshmi TS published an article in 2020 resulting in the production of exopolysaccharide by *Pseudomonas stutzeri* with the use of MOPS and $FeSO_4$ in basal media. Collection of bacterial exopolysaccharides was done with the help of solvent and is estimated by phenol sulfuric method. Characterization of bacterial alginate was done in this study. Efficiency of bacterial alginate for heavy metal removal property was also studied. [Meena, 2020]

Kamila Myszka, Katarzyna Czaczyk published an article in 2009. According to this, isolation of bacterial exopolysaccharide was done and is quantified. In this study, after a starvation period of 144 hours, only glucosyl units were detected in the extracellular matrix. It was found that when *Pseudomonas aeruginosa* was provided with nutrient-rich conditions, the EPS composed of glucose contributed only 3%. However, under optimal nutrients availability, the glucose content in the EPS significantly increased to 26%. [Myszka, 2009]

Filomena Freitas, Vitor D. Alves, Joana Pais, Nuno Costa, Cristina Oliveira, Luis Mafra, Loic Hilliou, Rui Oliveira, Maria A. M. Reis published an article in 2008. According to this, the studied mentioned the only carbon source is glycerol, which results in the production of EPS in 96 and 144 hours with the production of 7-18 g/L of EPS. Study also shows the activity of EPS as flocculating agent and a significant emulsifying activity. [Freitas, 2008]

Ozlem Ates published an article in 2015 evaluating the role of EPS and its mechanism is studied. Bacterial synthesis of EPS, its mechanism and regulation and genome-scale metabolic has been discussed. [Ates, 2015]

R. Vidhyalakshmi, C. Valli Nachiyar, G. Narendra Kumar, Swetha Sunkar, Iffath Badsha published an article in 2018. According to them, bacterial isolation and an attempt of EPS production for the making of emulsifiers for the preparations of safe creams and lotions was studied. Emulsification activity of *P. fluorescens* was checked against diesel and olive oil. [Vidhyalakshmi, 2018]

Viviana Urtuvia, Nataly Maturana, Fernando Acevedo, Carlos Pena published an article in 2017 evaluating the bacterial alginate production, its mechanism and its regulation of gene. Study also shows alginate comparison to *Azotobacter vinelandii* and *Pseudomonas* spp. [Urtuvia, 2017]

DISCUSSION:

The production of biosurfactants and alginate from exopolysaccharides (EPS) derived from *Pseudomonas aeruginosa* and *Pseudomonas putida* presents promising opportunities for sustainable and eco-friendly biotechnology. These bacterial species are renowned for their capacity to produce a diverse range of EPS, which includes these two valuable biomolecules.

Optimization of production maximize the production of biosurfactants and alginate, it is crucial to optimize culture conditions, including nutrient composition, pH, temperature, and aeration. Additionally, exploring different extraction methods can significantly impact the yield and purity of these biomolecules. According to the Freitas et. Al. and Myszka et. Al., production of EPSs can be optimised according to the starvation conditions provided or the supplement of a specific nutrient component given can lead to desired character of EPS produced.

Biosurfactants derived from *Pseudomonas* species exhibit a wide range of properties, such as low toxicity, biodegradability, and high surface activity.

These properties make them attractive alternatives to synthetic surfactants in various applications. For example, biosurfactants can be used to enhance oil recovery, improve soil remediation, and develop novel drug delivery systems.

Alginate is a valuable EPS produced by *Pseudomonas* species. This versatile biopolymer has many applications in the food, pharmaceutical, and biomedical industries. In the food sector, it is commonly used as a thickening, stabilizing, and gelling agent, while in pharmaceuticals, it serves as a drug delivery carrier in various formulations.

CONCLUSION :

By leveraging the capabilities of *Pseudomonas* species to produce biosurfactants and alginate, we can contribute to the development of sustainable and environmentally friendly technologies that address global challenges. Future research should focus on establishing efficient and cost- effective methods for the large-scale production of biosurfactants and alginate from *Pseudomonas* species. Genetic engineering techniques can enhance the production of these biomolecules by overexpressing specific genes involved in their biosynthesis. Furthermore, exploring novel applications of these biomolecules in emerging fields such as nanotechnology and tissue engineering could open up exciting new avenues for research and development.

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