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Mini review article

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Optimisation and acceleration of amphiphilic biosurfactants by overcoming challenges of production

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Abstract

Biosurfactants are structurally the surface-active molecules synthesised by micro-organisms. They have the capability of reducing surface and interfacial tension with low toxicity and high specificity. They encompass the properties, such as dropping surface tension, stabilising emulsions, foaming promotion and are usually non-toxic and biodegradable. Interest in biosurfactants has been increasing in recent years owing to their diversity, environment-friendly nature, possibility of large-scale production, selectivity, performance and impending applications in environmental fortification. Presently, the production of biosurfactants is highly expensive due to the use of synthetic culture media. This review article represents the current developments and future perspectives of a variety of approaches in biosurfactants production.

Keywords
Biosurfactants; *Optimisation*; *Economic factors*; *Environmental factors*

Introduction

Biosurfactants are amphiphilic biological compounds produced extracellularly or as a part of the cell membrane by a variety of yeast, bacteria and filamentous fungi.[1] They are characterised by low aqueous solubility and high solid-water distribution ratios.[2] Surfactants which are produced by certain species of bacteria and yeasts exhibit an effective antimicrobial activity.[3] Biosurfactants have advantages over their chemical counterparts because of their low toxicity[4] and effectiveness at extreme temperatures or pH values.[5] These compounds find applications in a variety of industrial processes, involving emulsification, foaming, detergency, wetting and dispersion.[6] Synthetic surfactants possess high degree of branching which results in poor degradability.[7] Surfactants are widely used in the industrial, agricultural foods, cosmetics and pharmaceutical applications, but most of these compounds are synthesised chemically, which potentially cause environmental and toxicological problems as a result of persistent nature of these substances.[8] With current advances in biotechnology, attention has been paid to the alternative environment-friendly process for the production of different types of biosurfactants from micro-organisms.[9] Some biosurfactants have therapeutic applications.[10] Biosurfactants are further divided into six classes: hydroxyllated and cross linked fatty acids (mycolic acids), glycolipids, lipopolysaccharides, lipoproteins-lipopeptides, phospholipids and the complete cell surface itself.

Steps involved in the process of optimisation

The quantity of biosurfactants production depends on several conditions, such as pH, temperature, carbon and nitrogen sources, aeration, and agitation.[11] At present, there are many studies regarding biosurfactants production, which relate the optimisation of their physical and chemical properties.[12] In order to acquire large quantities of biosurfactants, it is essential to optimise the process conditions. Several elements, such as addition of iron and manganese to the medium increase the biosurfactants production from *B. subtilis*. The ratio of different elements along with carbon in the media, such as C:N and C:P increased their production.[13]

Response surface methodology (RSM) detects the relationship between explanatory and response variables. This method can be used to determine the optimum media, inoculum and environmental conditions for the enhanced production of surfactins by *Acinetobacter* sp.[1] and the probiotic bacterial strains of *Lactococcus lactis* and *Streptococcus thermophiles*.[14] This method would be helpful in commercialisation i.e. to design the best combination of cheaper substrates and to use them in most favourable environmental conditions.

Sources required for the production of biosurfactants

Use of carbon and nitrogen sources

Till date, biosurfactants cannot compete with chemically synthesised compounds because of their high production costs.[15] These costs could be decreased by the use of alternative sources, such as glucose, glycerol and sodium acetate,[16] and the result of increased synthesis of surfactants was obtained with the alternate sources by *Yarrowia lipolytica* NCIM 3589. Similarly, biosurfactants produced by *Y. lipolytica* IA 1055 using glucose as a carbon source had proved that, the biosurfactants production does not depend on the presence of hydrocarbons.[17] Proteins have been produced from *Kluyveromyces marxianus*[18] with the utilisation of lactose as a substrate. Various sources of nitrogen were used for the biosurfactants production, such as urea, peptone, ammonium sulphate biosurfactants production, such as urea, peptone, ammonium sulphate, ammonium nitrate, sodium nitrate and meat extract.[19] Yeast extract is the most widely used nitrogen source for the biosurfactants production, but its concentration depends upon the nature of micro-organism, and the medium used. The yeast, *Rhodotorula glutinis* IIP30 had shown better yield with potassium nitrate during the production of biosurfactants.[20]

Impact of environmental factors

Environmental factors, such as pH, temperature, etc., play a significant role in the yield of biosurfactants.

Effect of pH

The effect of pH in biosurfactants production by *C. antarctica* was demonstrated by using phosphate buffer (pH 4–8), which resulted in the reduction of biosurfactants yield.[7] The best yield of biosurfactants was achieved when the pH was 7.0.[17]

Effect of temperature

Many micro-organisms grow well and produce a good yield of biosurfactants at 25 to 30°C.[11] In *C. bombicola*, maximum activity was observed at 30°C; whereas, 27°C acted as a suitable temperature for the sophorolipids production. The lipid production was usually observed at 25°C.

Effect of aeration and agitation

On aeration, with rate flow of 1 vvm and dissolved O_2 of 50% saturation, *C. antartica* had shown the maximum production (45.5 gl^{-1}). *Acinetobacter calcoaceticus* produced less biosurfactants due to the maintenance of high shear stress, which inversed with yeasts.[6] Several attempts were made to reduce the inhibition step by means of implementation of isolation.[7]

Conclusion

An increased production of biosurfactants can be achieved by modifying the media composition that is required to overcome the present challenges.

The use of biosurfactants has been limited due to the cost involved in the biosurfactants production. To overcome this obstacle and compete with synthetic surfactants, development and research in this field would perspectively result in the commercialisation of biosurfactants.

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