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Biosurfactant: Its advancement in Agriculture

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SUMMARY

Biosurfactants are compounds which have both hydrophobic and hydrophilic moieties and they were produced in living spaces or excreted extracellular that confers on the organism to accumulate between fluid phases. Biosurfactants were produced by bacteria, fungi, yeasts and other microorganisms etc. so they are known as green surfactants. The physiological role of biosurfactant production depends in the antimicrobial activity and substrate availability for uptake by the cells in harsh environmental conditions. Unique property of biosurfactants are biodegradable and lesser toxicity level, while some of its limitations are unable to scale up the production process and patent rights. Biosurfactants are considered to be less toxic and eco-friendly and can widely be applied for improving the agricultural soil quality by soil remediation. Conventional methods for isolation of biosurfactants producing bacteria include screening the microbial population from different sources. However, molecular methods are fewer, so there is a need to explore novel biosurfactants from uncultured microbes in soil to explore the production of biosurfactants

INTRODUCTION

With the increase in human population, people need to meet the food demands of human population. People were concern for the improvement of native soil systems for improved crop yield. Many microorganisms found in rhizosphere (the soil under the influence of plant roots) share a mutualistic relationship with plants giving beneficial effects on plants .There were many reports of soil and surface water locations that are contaminated with organic pollutants such as hydrocarbons etc. Because of its low solubility in water and high tension, these contaminants cannot be easily removed. Biosurfactants produced by the microorganisms in the environment help to take up the hydrocarbons as carbon source, either by making available the hydrocarbon by releasing biosurfactants into the environment or by changing its cell surface so that the contaminant can be absorbed. Synthetic surfactants are highly toxic and hardly degradable causing damage to the environment. Biological treatment offers more eco-friendly as well as low cost techniques, since organic components that account for less toxicity may be converted to H_2O and CO_2 through familiar biological pathways. Bacterial biosurfactants production has been explored extensively whereas in case of fungus, very fewer fungi are known to produce biosurfactants. Examples *Pseudomonas aeruginosa*, *Mycobacterium sp*.,*Aspergillus, Corynebacterium sp*.

Molecular Methods of Profiling of Biosurfactant Producing Community from Agriculture Soil:

Techniques for purification of biosurfactants includes chromatography (Baker et al.,2010) and then followed by the characterization of the biomolecules by infra-red, gas chromatography mass spectrometry, nuclear magnetic resonance and fast atom bombardment mass spectrometry (Petrovic et al.,2004; Satpute et al. 2010b).Recently, MALDI-TOF mass spectrometry is reported for detection and separation of biosurfactants (Kurtzman et al. 2010)Along with the traditional methods, molecular techniques are being implemented to detect presence of biosurfactant producing bacteria. Techniques such as PCR, cloning, sequencing etc. were employed for isolation of biosurfactant.

The following are the steps that can be employed for molecular characterization of biosurfactant production in bacteria from selected habitat especially hydrocarbon/crude oil/ heavy metal-contaminated agricultural soil:

1.From the soil samples, DNA can be extracted directly and analysed by characterising the particular targeted sequences and amplified by PCR.
2.PCR products were analysed by cloning and simple electrophoresis techniques. These PCR products enables the analysis of the genetic structure of the community.
3.The genetic diversity of the community of bacteria can be assessed by the characterisation of the cloned sequences.

4.Identification of particular populations which type of biosurfactant is dominant in the selected niche were done by sequencing of the DNA bands.
5.FISH, SIP, DNA microarray technology were the techniques that help to assess the genetic structure of biosurfactants producing communities.

Another method for screening unculturable microbes for biosurfactant production from agriculture soil is the metagenomic approach. Metagenomics is the culture-independent genomic analysis of microbial communities, which is used for exploring novel compounds from uncultured bacteria associated with natural ecosystems. No PCR is involved in the metagenomics and the whole soil microbes DNA is cloned and sequenced (Sachdev et al.,2013).

Agricultural Related Applications of Biosurfactant

Enhancement of Plant Microbe Interaction

To provide beneficial effect to the plants by rhizobacteria, they interact with the plant surfaces such as roots to increase the bioavailability of hydrophobic molecules which may serve as nutrients (Nihorimbere et al. 2011). Biosurfactants affect the motility of microorganisms; participate in signaling and differentiation as well as in biofilm formation (Ronand Rosenberg2011; Berti et al.2007). Hence, biosurfactants are important for microbes to achieve a beneficial association with the plant roots and improve the growth of the plant.

Improvement of Soil Quality

Biosurfactant can be applied in agriculture soil to enhance soil quality. Contaminated soil by hydrocarbon and heavy metals can be recovered by the process of bioremediation. Microorganisms producing biosurfactant can be effectively used for removal of hydrocarbons as well as heavy metals. Biosurfactants can also enhance the degradation of certain chemical insecticides which are accumulated in the agricultural soil (Zhang et al. 2011a; Singh et al. 2009; Sharma et al. 2009).The heavy metals serve as essential micronutrients however it can be detrimental to plant growth at higher concentrations causing damage to plant in form of root tissue necrosis and purpling of foliage.some biosurfactants producing organisms are *Pseudomonas sp, Bacillus sp., and Acinetobacter sp*.(Pacwa-Plociniczak et al. 2011).

Application in Pesticide Industries

Surfactants are with fungicides, insecticides, and herbicides properties so they are widely used in formulation of pesticides. However, the surfactants present in pesticides formulations in excess becomes accumulated in soil and affects the texture, colour and growth of the plant(Petrovic and Barcelo 2004). Considering the adverse effect of pesticides and surfactants, there is needed to use the environmentally safe biosurfactants to replace these harmful surfactants to prevent the pollutions (Hopkinson et al. 1997). Agricultural pesticides formed with the assistance of biosurfactant can be widely used on agricultural fields.

Plant Pathogen Elimination

Since biosurfactants have antimicrobial activity against plant pathogens,it also facilitates biocontrol mechanism of plant growth promoting microbes such as parasitism, competition, and hypovirulence. These surfactants are used in combination with fungus (*Myrothecium verrucaria*) to eradicate weed species which affect the land productivity because the spread of such weed species have adverse effect on biodiversity.Biosurfactant producing rhizospheric isolates of *Pseudomonas* and *Bacillus* have exhibited biocontrol of soft rot causing Pectobacterium and Dickeya spp.(Krzyzanowska et al. 2012).

CONCLUSION

It is well said that the biosurfactants are biodegradable product and is very good for biodegradation of oils, controlling environmental pollution, oil fields, removal of oil pollutions, applications in agriculture and agrochemical industries. Using cheap agro industrial wastes and use of oil as substrates, the production of biosurfactants made it easy. Production of biosurfactants is better efficient as compared to the other microbes. Biosurfactants were used as biocontrol agents due to its antimicrobial property. The agricultural wastes were also

be used for the biosurfactants production. Since most of the biosurfactants are produced in small scale at laboratory so there is a need to be focused toward production in large or industrial scale. Despite of having so many advantages of biosurfactants, its industrial use is still limited due to the involvement of high cost in its production process. Biosurfactants have wide applications in human welfare for present and future generations due to non-toxic and eco-friendly nature.

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