Microbial Biosurfactants: From an Environmental Application Point of View

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Microbial biosurfactants are extracellular compounds produced by microbes such as bacteria, fungi and actinomycetes when grown in culture medium containing hydrophobic/hydrophilic substrates. Biosurfactants are surface active molecules having hydrophilic and hydrophobic moieties as their constituents which allow them to interact at interfaces and reduce the surface tension. Biosurfactants are classified into many groups based on their chemical composition as fatty acids, glycolipids, glycolipopeptides, glycoproteins, lipopeptides, phospholipids, polymeric and particulate biosurfactants [1]. The chemical diversity of biosurfactants make them a source for green chemicals having many potential applications for the environment. As compared to their chemical/synthetic counterparts, biosurfactants have unique properties such as high activity, less/no toxicity, biodegradability and ease of production from renewable resources [2,3].

Biosurfactants are used in many environmental sectors such as i) bioremediation of oil, heavy metals and pesticides, ii) enhanced oil recovery (EOR) and iii) antimicrobial agents e.g., biopesticides in agriculture. In bioremediation applications biosurfactants play main role in promoting the accessibility/bioavailability of the pollutants to the microbes involved in biodegradation process. Application of biosurfactants in oil biodegradation experiments showed 20-30% increase in total degradation [3]. In heavy metal remediation - biosurfactants form ionic bonds with metals. These bonds are stronger than the metal’s bonds with the soil and metal-biosurfactant complexes are desorbed from the soil matrix to the water phase due to lowering of the interfacial tension. EOR represents one of the most advanced methods to recover entrapped oil using aqueous surfactant formulation that is injected into a mature oil reservoir. The biosurfactant solution applied to the oil field contacts the small pockets of trapped oil and reduces the interfacial tension, mobilizes the trapped oil and thus the released oil can be recovered more efficiently. Application of biosurfactants as biopesticides is an emerging field and so far three microbial surfactants (lipopeptides, rhamnolipids and sophorolipids) have been found with significant biopesticidal activity against plant pathogens. The mechanism of antimicrobial activity associated with biosurfactants is because of the perturbation of membrane constituents that leads to cell wall disruption.

Despite the benevolent properties of biosurfactants, there are many challenges that remain unsolved in the field of biosurfactant science. Aforementioned uses/applications of biosurfactants in the environment are few examples but still there are many unknown applications of biosurfactants that remain a quest for the scientists. Another important area that needs extensive research in biosurfactant science is the commercial production of biosurfactants. Other than sophorolipids (from the yeast Candida bombicola) and rhamnolipids (from Pseudomonas aeruginosa) large scale production of biosurfactants remains a challenging task. In addition to above challenges, information on toxicity of biosurfactants on other living organisms is limited or in some cases there is no information at all.

There are few aspects of the biosurfactant technology that are worth further investigation and may make biosurfactants a versatile eco-friendly molecule for many applications.

1. Development of cost effective production techniques.
2. Identification of new applications.
3. Isolation of new biosurfactant producing safe to handle strains from various environments.
4. Evaluation of toxicity of biosurfactants on microbes, animals and plants.
5. Research on biodegradation of biosurfactants in the environment.

References

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