



**International Journal of Biology, Pharmacy
and Allied Sciences (IJBPAS)**

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

**BIOSURFACTANT AND ITS APPLICATION REVIEW: MORE EMPHASIS ON
AGRICULTURE**

ZALA US AND SHRIVASTAV A*

Department of Microbiology, Parul Institute of Applied Sciences, Parul University, Limda,
Waghodia, Vadodara, Gujarat, India

*Corresponding Author: E Mail: anupama.shrivastav82045@paruluniversity.ac.in

Received 9th Nov. 2019; Revised 3rd Dec. 2019; Accepted 17th Jan. 2020; Available online 1st July 2020

<https://doi.org/10.31032/IJBPAS/2020/9.7.5118>

ABSTRACT

Biosurfactants bio-molecules are those kinds of biomolecules which have surface-active properties. They are produced by microbes and they have several advantages compare to the chemical surfactants, like lower toxicity, higher biodegradability.

Biosurfactants have very high capabilities like they are highly selective in nature, they are very good foaming agent, they show very good specific activity even in extreme conditions like temperature, ph, and salinity. Due to these capabilities they are widely used in many industries.

Many surfactants are available in the market are chemically synthesized. Usages of biosurfactants are increased because of their wide range of functional properties and the diverse synthetic capabilities of the microbes.

There are many advantages of microbial biosurfactants because they have wide range of applications protection of ecosystem. Microbial biosurfactants have very good capabilities of enhancing in oil recovery, controlling oil spills, biodegradation because of this advantages they are used in oil-contaminated industries.

Biosurfactants are also used in oil, and biodegradation industries. Thus In this review article, we concentrated on, exploring application of biosurfactants in agriculture and investigating their potential role in plant growth promotion and other related agricultural applications.

Keywords: Biosurfactant, biodegradation, Agriculture, microbes

INTRODUCTION

The word surfactant shows a surface-active agent. There are many capabilities of surfactants like they lower the surface tension or interfacial tension between two liquids, between a gas and a liquid, or between a liquid and a solid.

There are many industries used surfactants in a product like detergents, wetting agents, dispersants, foaming agents and emulsifiers.

Schematic diagram (**Figure 1**) of a micelle of oil in aqueous suspension, such as might occur in an emulsion of oil in water. The **Figure 1** shows the, surfactant molecules' oil-soluble tails project into the oil (blue), while the water-soluble ends remain in contact with the water phase (red). Surfactants are usually organic compounds like amphiphilic, meaning they contain both hydrophobic groups (their tails) and hydrophilic groups (their heads). Moreover, a surfactant contains both water-insoluble (or oil-soluble) component and a water-soluble component.

Surface active compounds are chemically synthesized and commonly used in almost every sector of recent industry [1].

playing a very important role in making of products which are used in cleaning, wetting, dispersing, emulsifying, foaming and anti-foaming agents in many practical applications and products, including detergents, fabric softeners, emulsions,

soaps, paints, adhesives, inks, anti-fogs, ski waxes, snowboard wax, deinking of recycled papers, in flotation, washing and enzymatic processes, laxatives.

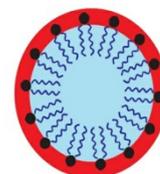


Figure 1: Schematic diagram of a micelle of oil

Surfactants Biosurfactans are used in agrochemical formulations like herbicides, biocides, insecticides and spermicides. Biosurfactants are used in making of Personal care products like shampoos, shower gel, cosmetics, hair-conditioners, and toothpastes. Surfactants are used in fire fighting products and pipelines products (liquid drag reducing agents). Alkali surfactant polymers are used to mobilize oil in oil wells [15]. Surfactants are used as plasticizer in nanocellulose [16] Ferrofluids, and leak detectors. Surfactants are used with quantum dots in order to manipulate growth [17]. Surfactants also helped in the assembly of the dots, reactions on their surface, electrical properties, etc., it is important to understand how surfactants arrange on the surface of the quantum dots [18].

Surfactants are used as a wetting agent in pharmaceutical industries, Because of when they dissolved in water, they act as lower the advancing contact angle, and aids in

displacing an air phase. And it is also replace with liquid.

Examples of Biosurfactant's application in pharmacy and medicine include the displacement of air from the surface of sulfur, charcoal, and other powders.

Biosurfactants have very wide applications like the displacement of air from the matrix of cotton pads and bandages so that medicinal solutions can be absorbed in various body areas. The use of detergents in the washing of wounds for free dirt and debris [14].

Biosurfactant:

Alternative biological surfactants are the most promising existing product [2].

Biosurfactants are surface-active substances synthesised by living cells.

The microbial surfactants have their own advantages like they have very diverse in nature, environmental friendly this feature leads to large-scale production, microbial surfactants give performance under extreme conditions, their applications also used in environmental protection [3, 4].

Biosurfactants widely used in many industries because of they give advantages in increase the demands of products because of biosurfactants are satisfy wider applications [5].

Biosurfactants are extracellular secondary metabolites, and their structure depends on carbon and nitrogen ratio and influences on total production [6].

Over synthetic surfactants, biosurfactants have several advantages: simplicity of syntheses, lower toxicity, action specificity and widespread applicability [7]. biosurfactants are used as moistening, dispersing, emulsifiers and foaming agents.

The beneficial effects of this field were paid attention for isolation and characterization of extremophiles produced biosurfactants [8].

Studies revealed that the biosurfactants keep its stable activity over a wide range of temperatures, highly alkalinity and hyper salinity over 15% [9].

A few of the popular examples of microbial biosurfactants includes Emulsan produced by *Acinetobacter calcoaceticus* [10] *Sphorolipids* produced by several yeasts belonging to candida and the *stamerella clade*, [11, 12] and Rhamnolipid produced by *Pseudomonas aeruginosa* [13] etc.

Biosurfactants also produced by some fungi species like *Aspergillus*, *Corynebacterium sp.*, *Dietzia sp.*, *Gordonia- sp.*, *William-sp.*, *Tsukamurella sp.* [33].

Biosurfactants have classified many groups including their mass also, like there are two groups based on their mass. 1. Low mass bio surfactants. 2. High mass biosurfactants. The low mass biosurfactants have glycolipid, phospholipid, lipopeptides, lipoproteins and fatty acids. The high mass biosurfactant have polymeric and particulate surfactant [32].

Biosurfactants are used in Flotation, washing and enzymatic processes, laxatives. Biosurfactants are also used in agro chemical solutions like Herbicides, insecticides, biocides, and spermicides (nonoxynol-9). Biosurfactants used in making of Personal care products such as cosmetics, shampoos, shewergel, hairco nditioners (after shampoo), toothpastes. Surfactants are widely used in fire fighting and pipelines because of they are liquid drag reducing agents. Alkali surfactant polymers are used to mobilize oil in oil wells [15].

Application of Biosurfactant:

In the different environments the biosurfactant producing microbes can be found.

There are many places where biosurfactant producing microbes were isolated from soils or water which contaminated by hydrophobic organic compounds. Ex: refinery wastes.

Application of biosurfactant in food processing industry

Biosurfactants used in very various food processing applications, they are generally used as a food formulation ingredient and anti-adhesive agents, like food formulation ingredient they promote the formation and stabilization of emulsion because of their ability to decrease the surface and interfacial tension.

It is also used to control the agglomeration of fat globules, stabilize aerated systems, improve texture and shelf -life of starch-containing products, modify rheological properties of wheat dough and improve consistency and texture of fat based products.

Application of biosurfactants in medicine

Antimicrobial activity: The diverse structures of biosurfactants give ability to them the display versatile performance. By its structure, biosurfactants explore its toxicity on the cell membrane permeability bearing the similitude of a detergent like effect.

There are many biosurfactants have strong antibacterial, antifungal and antiviral activity; these surfactants play the role of anti adhesive agents to pathogens making them useful for treating many diseases as well as its use as therapeutic and probiotic agent.

The biosurfactant also produced by marine *B.circulance* which had a potential of antimicrobial activity against gram positive and gram negative pathogens and semi pathogenic microbial strains. It shows antimicrobial activity in MDR (Multi-drug-resistant) strains also.

Application of biosurfactant in petroleum

Biosurfactant and bioemulsifiers are important group of molecules and among the most powerful and versatile by-product

that modern microbial technology can offer in fields such as bio-corrosion and biofouling degradation of hydrocarbons. Biosurfactants are also used as a product in oil reservoirs, enzymes and biocatalysts for petroleum up-grading.

Moreover, biosurfactants play a major role in petroleum extraction, transportation, upgrading and refining and petrochemical manufacturing.

Biosurfactants as Biopesticide

Conventional arthropod control strategy involves applications of broad-spectrum chemicals and pesticides, which often produce undesirable effects.

Further, emergence of pesticide resistant insect populations as well as rising prices of new chemical pesticides have stimulated the search for new eco-friendly vector control tools.

The Lipopeptide biosurfactants also used as a biopesticides by using some kind of bacteria which shows an exhibit insecticidal activity against fruit fly like *Drosophila melanogaster*.

Application of Biosurfactant in Agro Industry

The biosurfactants have more advantages as compared to the chemically synthesized surfactants in the field of agriculture.

The soil remediation is also done by biosurfactant for improving the soil quality. This biosurfactants can replace the many pesticides products which are help in

improving soil by many million-dollar agro industries.

Thus, exploring biosurfactants from environmental isolates for investigating their potential role in plant growth promotion and other related agricultural applications warrants details research.

There are several conventional methods for production of biosurfactant. Screening the microbial population is one of them. There are other methods also like molecular methods.

Molecular methods are not that much capable like screening methods. There are some limitations of molecular methods like they less in reaching from microbial population to extract biosurfactants. Other methods like functional metagenomics, in this method isolate novel biosurfactant from uncultured microbes in soil biosphere [19].

Bioremediation process is required in to increase the quality of such soil contaminated by hydrocarbon and heavy metals. Biosurfactants are produced by microorganisms which are effectively used for removal of hydrocarbons as well as heavy metals [20].

The biosurfactant which are present in soil it is accelerated soil particles to tightly bound with hydrophobic pollutants. This phenomenon is a very important of desorption. This is very important for bioremediation process.

Biosurfactants can also enhance the degradation of certain chemical insecticides which are accumulated in the agricultural soil [21-23].

Lactobacillus pentosus are also produced biosurfactant. This biosurfactant reduced 58.6% to 62.8% of octane hydrocarbon from soil [24], this is the one kind of biodegradation accelerator property of biosurfactant.

There are many kind of bacteria produce lipopeptide biosurfactants. This kind of biosurfactants shows an insecticidal activity against fruit fly *Drosophila melanogaster*. Then this biosurfactants are used as a biopesticide [25].

Several bacteria produce lipopeptide biosurfactants which exhibits insecticidal activity against fruit fly *Drosophila melanogaster* and hence can be used as biopesticide [25].

The surfactants have many applications in agriculture field because of they have heavy metal properties which are used in making of metal salt-based fungicides, sewage, and sludge amendments. Due to this heavy metal pollution generates.

The biosurfactants which are produced by *Pseudomonas* sp, *Bacillus* sp., and *Acinetobacter* sp., have several potential properties like removal of heavy metals from oil contaminated soil and they are helping in acceleration of biodegradation in pesticides [26, 27].

There are many biosurfactants which are derived from microbes they have antimicrobial activity against plant pathogens, they are achieving sustainable agriculture with a promising bio control molecule. Rhizobacteria produced biosurfactants. This biosurfactants have antagonist properties [28].

There are many applications of chemical surfactants in agricultural field like they have used in plant growth promoting microbes (PGPM) like induced systemic resistance, parasitism, hypovirulence, competition, and antibiosis.

There is much kind of lipopeptide biosurfactants which are produced by strains of *Bacillus*. Then inhibition growth of phytopathogenic fungi (*Fusarium* spp.) This kind of biosurfactant used a biocontrol agent [30].

There is a very important kind of pathogen *Pseudomonas aeruginosa* which is inhibited by biosurfactant. This kind of biosurfactant is isolated from crude oil- contaminated soil [31].

CONCLUSION

Surfactants have several applications in agriculture and agrochemical industries. However, there is rare use of biosurfactants which are more environmental friendly. Further investigation is required to understand the exact role of surfactant in facilitating other systems as biocontrol agents. Such studies will help in replacing

the harsh chemical surfactants with green ones. Mainly species of *Pseudomonas* and *Bacillus* appear in literature as producers of biosurfactants indicating that only limited genera have been studied till date. Intense work on green surfactants is a priority to prevent the adverse effects of synthetic surfactants largely employed in many commercial sectors including agrochemical industries.

REFERENCES

- [1] Samadi, N., Fazeli, M. R., Abadian, N., Akhavan, A., Tahzibi, A., Jamalifar, H., 2007. Biosurfactant production by the strain isolated from contaminated soil. *J. Biol. Sci.* 7, 1266-1269.
- [2] M. Henkel, M.M. Müller, J.H. Kügl er, R.B. Lovaglio, J. Contiero, C. Syl datk Rhamnolipids as biosurfactants from renewable resources: concepts for next-generation rhamnolipid production, *Process Biochem.*, 47 (8) (2012), pp. 1207-1226
- [3] Banat IM, Makkar RS, Cameotra SS (May 2000). "Potential commercial applications of microbial surfactants". *Appl. Microbiol. Biotechnol.* 53 (5): 495–508. doi:10.1007/s002530051648. PMID 10855707.
- [4] Rahman KS, Rahman TJ, McClean S, Marchant R, Banat IM (2002). "Rhamnolipid biosurfactant production by strains of *Pseudomonas aeruginosa* using low-cost raw materials". *Biotechnol. Prog.* 18 (6): 1277–81. doi: 10.1021/ bp 020071x. PMID 12467462.
- [5] D.P. Sachdev, S.S. Cameotra Biosurfactants in agriculture, *Appl. Microbiol. Biotechnol.*, 97 (3) (2013), pp. 1005-1016.
- [6] T. Janek, M. Łukaszewicza, A. Kra sowska. Identification and characterization of biosurfactants produced by the Arctic bacterium *Pseudomonas putida* BD 2, *Colloids Surf. B*, 110 (2013)
- [7] A. Kumar, K. Mody, B. Jha. Evaluation of biosurfactant/ bioemulsifier production by a marine bacterium, *Bull. Environ. Contam. Toxicol.*, 79 (2008), pp. 617-621
- [8] M. Putri, R. Hertad Effect of glycerol as carbon source for biosurfactant production by halophilic bacteria *Pseudomonas stutzeri* BK - AB12, *Procedia Chem.*, 16 (2015), pp. 321-327
- [9] Khoulood M. Barakata Sahar W.M. Hassana Osama M. Darweshb, Biosurfactant production by haloalkaliphilic *Bacillus* strains

- isolated from Red Sea, Egypt. The Egyptian Journal of Aquatic Research, Volume 43, Issue 3, September 2017, Pages 205-211.
- [10] Shoham Y, Rosenberg M, Rosenberg E (September 1983). "Bacterial degradation of emulsan". Appl. Environ. Microbiol. 46 (3): 573–9. PMC 239318. PMID 6688940.
- [11] Kurtzman CP, Price NP, Ray KJ, Kuo TM (October 2010). "Production of sophorolipid biosurfactants by multiple species of the *Starmerella* (*Candida*) *bombicola* yeast clade". FEMS Microbiol. Lett. 311 (2): 140–6. doi:10.1111/j.1574-6968.2010.02082.x. PMID 20738402.
- [12] Parekh, V. J.; Pandit, A. B. (2011). "Optimization of fermentative production of sophorolipid biosurfactant by *starmerella bombicola* NRRL Y-17069 using response surface methodology". International Journal of Pharmacy and Biological Sciences. 1 (3): 103–116.
- [13] Ito S, Honda H, Tomita F, Suzuki T (December 1971). "Rhamnolipids produced by *Pseudomonas aeruginosa* grown on n-paraffin (mixture of C 12, C 13 and C 14 fractions)". J. Antibiot. 24 (12): 855–9. doi:10.7164/antibiotics.24.855. PMID 4334639.
- [14] Percival, S.I.; Mayer, D.; Malone, M.; Swanson, T; Gibson, D.; Schultz, G. (2 November 2017). "Surfactants and their role in wound cleansing and biofilm management". Journal of Wound Care. 26 (11): 680–690. doi:10.12968/jowc.2017.26.11.680. ISSN 0969-0700. PMID 29131752
- [15] Hakiki, F.; Maharsi, D.A.; Marhaendrajana, T. (2016). "Surfactant-Polymer Coreflood Simulation and Uncertainty Analysis Derived from Laboratory Study". Journal of Engg. and Technol. Sci. 47 (6): 706–724. doi:10.5614/j.eng.technol.sci.2015.47.6.9
- [16] Murray, C. B.; Kagan, C. R.; Bawendi, M. G. (2000). "Synthesis and Characterization of Monodisperse Nanocrystals and Close-Packed Nanocrystal Assemblies". Annual Review of Materials Research. 30 (1): 545–610. Bibcode: 2000AnRMS.30.545M. doi:10.1146/annurev.matsci.30.1.545

- [17] Zherebetsky D, Scheele M, Zhang Y, Bronstein N, Thompson C, Britt D, Salmeron M, Alivisatos P, Wang LW (June 2014). "Hydroxylation of the surface of PbS nanocrystals passivated with oleic acid". *Science*. 344 (6190): 13804. Bibcode: 2014. *Sci*. 344.1380Z. doi:10.1126/science.1252727. PMID 24876347
- [18] Ying Yong Sheng Tai Xue Bao. 2006 Jun; 17(6):1123-8. Sun X, Wu L, Luo Y, Application of organic agents in remediation of heavy metals- contaminated soil.
- [19] Zhang C, Wang S, Yan Y, *Bioresour Technol*. 2011 Jul; 102(14):7139-46 Isomerization and biodegradation of beta-cypermethrin by *Pseudomonas aeruginosa* CH7 with biosurfactant production.
- [20] Singh A, Van Hamme JD, Ward OP Application aspects. *Biotechnol Adv*. 2007 Jan-Feb; 25(1):99-121.
- [21] Sharma S, Singh P, Raj M, Chadha BS, Saini HS J. Surfactants in microbiology and biotechnology: Part 2. *Hazard Mater*. 2009 Nov 15; 171(1-3):1178-82. Aqueous phase partitioning of hexachloro-cyclohexane (HCH) isomers by biosurfactant produced by *Pseudomonas aeruginosa* WH-2.
- [22] Moldes AB, Paradelo R, Rubinos D, Devesa-Rey R, Cruz JM, Barral MT, Ex situ treatment of hydrocarbon-contaminated soil using biosurfactants from *Lactobacillus pentosus*. *J Agric Food Chem*. 2011 Sep 14; 59(17):9443-7.
- [23] Selection of microbes producing biosurfactants in media without hydrocarbons, Mulligan, C., Cooper, D. and Neufeld, R. 1984.. *Journal of Fermentation Technology*. 62(4):311-314.
- [24] Pacwa-Płociniczak M, Płaza GA, Piotrowska-Seget Z, Cameotra SS. Environmental applications of biosurfactants: recent advances. *Int J Mol Sci*. 2011 Jan 18; 12(1):633-54.
- [25] Kassab DM, Roane TM, Differential responses of a mine tailings *Pseudomonas* isolate to cadmium and lead exposures., *Biodegradation*. 2006 Aug; 17(4):379-87.
- [26] Nihorimbere V, Marc Ongena M, Smargiassi M, Thonart P. Beneficial effect of the rhizosphere microbial community for plant growth and

- health. *Biotechnol Agron Soc Environ.* 2011; 15: 327–337.
- [27] Singh A, Van Hamme JD, Ward OP, Surfactants in microbiology and biotechnology: Part 2. Application aspects. *Biotechnol Adv.* 2007 Jan-Feb; 25(1): 99-121
- [28] Velho RV, Medina LF, Segalin J, Brandelli A, *Folia Microbiol (Praha)*. Production of lipopeptides among *Bacillus* strains showing growth inhibition of phytopathogenic fungi., 2011 Jul; 56(4):297-303.
- [29] Eddouaouda K, Mnif S, Badis A, Younes SB, Cherif S, Ferhat S, Mhiri N, Chamkha M, Sayadi S. *J Basic Microbiol.* 2012 Aug; 52(4): 408-18. Characterization of a novel biosurfactant produced by *Staphylococcus* sp. strain 1E with potential application on hydrocarbon bioremediation.
- [30] Priyam V and Dinesh Singh, Review on Biosurfactant Production and its Application, *Int. J. Curr. Microbiol. App. Sci* (2018) 7(8): 4228-4241
- [31] S., Ivshina, I. B., Baeva, T. A., Kochina, O. A., Gein, S. V. and Chereshev, V. A. 2015. Trehalolipid biosurfactants from nonpathogenic *Rhodococcus*, *Actinobacteria* with diverse immune modulatory activities. *New Biotechnology.* 32(6): 559-568.