STUDIES ON THE BIODEGRADATION OF SURFACTANT SODIUM DODECYL SULPHATE (SDS) BY MICROORGANISM IN BHOPAL, INDIA

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ABSTRACT
Surfactants are the largest class of compounds present in raw domestic wastewater. They are used in household and industrial laundry and cleaning operations. SDS is an anionic surfactant widely used all over the world, and it is an important foaming component of shampoos, toothpaste and detergents. Surfactants cause foam at sewage treatment plants and pollute underground water. Due to their toxic nature, their presence endangers the aquatic flora and fauna. Large quantities of SDS are released to the environment and this can cause problems in sewage treatment facilities due to their foaming capabilities and toxicity. They exert a solubilizing effect on many organic compounds and increase the carcinogenic impact. Microbial degradation is the most efficient way of SDS degradation and several enzymes are involved in SDS degradation. The breakdown of a substance as measured by a substance specific analytical method, for example, the loss of the sulphate groups from surfactants, such as SDS would be a primary biodegradation step that would lead to an immediate loss of surfactant properties. Measured by the methylene blue anionic surfactants (MBAS) reduction test.
Keywords: MBAS, SDS, Degradation, Surfactant, Toxic, Anionic

1. INTRODUCTION

Detergents are the group of chemical widely used in laundry industries and household cleaning products. The residuals of the detergents such as surfactants are discharge into environment after usage. Both surface water and underground water are prone to contamination due to such domestic waste. They also have impact on biodiversity of aquatic environment. The microorganism in the contaminated sites develops a bio-mechanism for their resistance and degradation of harmful heavy metals [1]. Sodium dodecyl sulfate (SDS) is one of the main surfactant components in detergents and cosmetics, used in high amounts as a detergent in products such as shampoos, car wash soap and toothpaste. Therefore, its bioremediation by suitable microorganisms is important [2]. The use of surfactants is increasing day by day. The byproducts of surfactants harm our atmosphere. Biodegradable surfactants are displacing conventional soaps and surfactants to control the harmful effects of uses of surfactants [3]. Surfactant contains both strong hydrophobic and hydrophilic moieties. According to the charge of their hydrophilic moiety, surfactants can be classified into four categories: anionic, non-ionic, cationic and amphoteric [4].

Biodegradation

Biodegradation is the process by which organic matter get decomposed by the action of micro-organisms present in aerobic or aerobic environment. After treatment done by micro-organisms, 50-90% of these organic substances utilized to provide the energy necessary to sustain life. Remained carbon content is used as building material for the microbial cell constituents like proteins, fats etc. The final products of the microbial degradation of organic substances are generally mineralization products like carbon dioxide, water and mineral salts and newly formed biomass. The

mineralization of organic materials consumed oxygen from environment that finally ends up in carbon dioxide, water and mineral salts etc. [5].

2. MATERIALS AND METHODS

2.1 Isolation and screening of SDS degrading bacteria

Collection of samples

The water sample was collected from different waste disposal sites of Bhopal, India. Water samples transfer to laboratory and will store at 4°C. This water samples was used for the isolation of bacteria.

2.2 Enrichment of sample

The five ml of water sample was taken and added to the flask containing 500 ml of basal medium (consisting of 1 gram/100 ml of SDS) for enrichment of bacteria. The conical flask was kept in shaker for incubation at 28ºC for "24 h" [6].

2.3 Enumeration and isolation of organisms

The enriched samples were taken for the isolation of bacteria. 0.1 ml of enrichment sample was spread on to basal medium agar plate containing (consisting of 1 gram per 100 ml) SDS as the only source of carbon energy. The plate was incubated at 28ºC (6). The incubated plates were observed for SDS degrading bacteria. The morphologically different colony was selected and streaked on fresh nutrient agar plate and incubated at 28ºC for "24 h". All the strains were preserved at 4ºC until further studies.

2.3 Screening for SDS degrading bacteria

All the selected bacterial strains were further screened for confirmation of SDS degrading activity. The bacterial strains were spotted on Bacto agar incorporated with (consisting of 1 gram per 100 ml) SDS. The plates were incubated at 28ºC for "24 h". After incubation, the plate were flooded with Lugol's iodine and observed for the zone of clearance around the bacterial growth. Strain which showed maximum zone of clearance on their preliminary screening that selected potential strain used for further studies.

2.4 SDS degradation study by Methylene Blue Active Substance (MBAS) assay

The concentration of residual SDS was determined by measuring the intensity of Methylene blue in a chloroform extraction process [7]. All the strains were inoculated with Basal medium and incubated at 28°C for "24 h". After incubation all the samples were studied for SDS degradation by using MBAS assay. Each 100 µl of culture were added in to the separated 100 ml of separating funnel containing 9.9 ml deionized water followed by the addition of 2.5 ml Methylene blue solution and 1 ml of chloroform. The funnel was shaken vigorously for 15 sec and the mixture was left to separate and settle. The chloroform layer was drawn off in to a second funnel. The extraction was repeated 3 times using 1 ml chloroform each time. All chloroform extracts were combined in the second funnel before adding 5.0 ml of wash solution. The funnel was then shaken vigorously for 15 sec. The chloroform layer was down off in to a volumetric flask. The was extracted twice with 1 ml of chloroform. All extracted were combined land diluted to the 10 ml mark with chloroform. The absorbance was read 652 nm against blank chloroform in quartz cuvette.

2.5 Characterization and identification of selected bacteria

The selected isolates were subjected to cultural, morphological, Microscopic observation, biochemical and selective media characteristic of potential SDS degrading strain was studied by adopting standard procedure and the potential strain was identified by using Bergey's Mannual of systematic bacteriology [8].

3. RESULTS

3.1 Screening and identification of SDS biodegrading bacteria

Screening of SDS degrading bacteria was screened by using Bacto Agar. Four bacteria were studied for the degrading activity. Hence these strains selected for MBAS assay.

3.2 SDS degradation study

Out of the four SDS- degrading bacteria isolated, isolate S4 exhibited a higher capability in degrading SDS with 85% degradation after four days incubations. Isolates S1, S2 and S3 exhibited lower potential in SDS degradation with only 69%, 50% and 40% degradation, respectively. The bacterial isolate from our laboratory was shown to degrade almost 85% of the SDS after four days of incubation based on the MBAS assay method.

3.3 Characterizatation and identification of potential strain

Morphological, Microscopic observation, biochemical and selective media characteristic of potential SDS degrading strain was studied by adopting standard procedure and the potential strain was identified by using Bergey's Mannual of systematic bacteriology. Based on the biochemical analysis the organisms identified as a *Pseudomonas sp.* (Table 1).

Table 1: Biochemical characterization of isolated organisms

S.NO.	Characterization	Bergey's Manual Result	Result
1	Gram Staining and shape	Gram Negative and rods	Gram Negative and rods
2	Motility	Motile	Motile
3	Catalase	Positive	Positive
4	Oxidase	Positive	Positive
5	Indole	Negative	Negative
6	Methyl red	Negative	Negative
7	Vogus Proskauer	Negative	Negative
8	Citrate	Positive	Positive
Cultural characterization			
1	Nutrient Agar	White color colonies was observed	

4. DISCUSSION

Surfactants are synthetic chemicals which are utilized as crude material in cleanser production. Sodium dodecyl sulfate, (SDS) is an anionic surfactant that broadly utilized everywhere throughout the world which represent severe hazards effects on the ambient environment [9]. According to literature data, anionic surfactants give toxic effects to various aquatic organisms at concentrations as low as 0.0025 mg l-1 [10]. In the present study, we have made an attempt to isolate SDS degrading bacteria from detergent polluted area situated in Bhopal, India. These areas where used extensively for washing of clothes and also for bathing purposes. Sodium dodecyl sulphate, (SDS) is an anionic surfactant that widely used all over the world. They will eventually end-up and accumulate in household or industrial sewage. Due to their high foaming capabilities, which can cause numerous problems in sewage treatment facilities as well as direct toxic effects on many different organisms in ecosystem; they are generally considered as serious pollutants. F. Hosseini and *et al* stated that the *Pseudomonas beteli* and *Acinetobacter johnsoni* isolates were able to degrade 97.2% and 96.4% of the original SDS levels after 10 days of growth; respectively [11].

5. CONCLUSION

After literature review it can be concluded that the obtained results anionic surfactants significantly biodegraded by bacteria. The gaining of knowledge on microbial metabolism in the natural environment can be used in the biodegradation of recalcitrant chemicals of anthropogenic origin. In the present investigation, the isolated bacteria from an SDS polluted water sample from Bhopal, India. Awareness on proper sewage treatment system and sanitation should be acquired among the people for the recycle the pollutants discharged in the water.

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REFERENCES

1. Benila Smily, J. M and Sumithra, P (2016). Degradation of Household detergents using fungi isolated from freshwater ecosystem. International Journal of Advanced Research in Biological Sciences. 3(9): 120-123.
2. Razieh Shahbazi, Roha Kasra-Kermanshahi, Sara Gharavi, Zahra Moosavi- Nejad and Faezeh Borzooee (2013). Screening of SDS-degrading bacteria from car wash wastewater and study of the alkylsulfatase enzyme activity. Iranian journal of microbiology. Volume 5: 153-158.
3. Divya Bajpai Tripathy, Anuradha Mishra, Anjali Gupta and Alpa Yadav (2017). Biodegradability of Laundry Detergent Surfactants. International Journal of Advance Research and Innovation. Volume 5, Issue 1: 130-136.
4. Mozia S, Tomaszewska, M. and Morawski K (2005). Decomposition of nonionic surfactant in a laby-rinth flow photoreactor with immobilized TiO2 bed. Applied catalyst Environ.59:155-160.
5. Matthew J Scott and Malcolm N Jones (2000). The Biodegradation of Surfactants in the Environment, Biochimica Et Biophysica Acta (Bba) - Biomembranes, 1508, 235–251.
6. Abboud MM, Khleifat KM, Batarseh M, Tarawneh KA and Al-Mustafa A, (2007) Different optimization conditions required for enhancing the biodegradation of linear alkylbenzosulfonate and sodium dodecyl sulfate surfactants by novel consortium of *Acinetobacter calcoaceticus* and *Pantoea agglomerans*. Enzyme Microbial Technol 41: 432-439.
7. Shukor MY, Husin WS, Rahman MF, Shamaan NA and Syed MA (2009). Isolation and Characterization of an SDS- degrading *klebsiella Oxytoca* J Envrion Biol 30: 129-134.
8. Holt, J. G., Krieg, N. R., Sneath, P. H. A., Staloj, J. T. and Williams, S. T (1994). Bergey's Manual of Determinative Bacteriology- 9th Ed. Williams and Wilkins. Baltimore/London.
9. Amany, G. Ibrahim and Hassan and E. Abd Elsalam (2018). Biodegradation of Anionic Surfactants (SDS) by Bacteria Isolated from Waste Water in Taif Governate. Annual Research & Review in Biology. 26(4): 1-13
10. Petterson, S. J., Scott, C. C and Tucker, K.B. E (2000). Nonionic detergent degradation. I. Thin layer chromatography and foaming properties of alcohol. Journal of American Oil Chemical Society. 47:37-41.
11. F. Hosseini, Malekzadeh, Amirmozafari and Ghaemi (2007). Biodegradation of anionic surfactants by isolated bacteria from activated sludge. Int. J. Environ. Sci. Tech., 4 (1): 127-132.