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**Research Article**


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# Degradation of Household detergents using fungi isolated from freshwater ecosystem

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## Abstract

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. Aquatic environment are rich in bacteria and fungi especially fungi belongs to genera Rhizopus, Aspergillus, Streptoverticillum, Sacchromyctes have excellent potential for heavy metal degradation. Hence, in the present investigation, the aquatic fungi were isolated from the detergent contaminated freshwater ecosystem and were employed for the degradation of commercial detergents. The degradation of surfactants is essential as they could impart serious threat to aquatic ecosystem.

**Keywords:** Surfactants, Detergents, fungi, degradation.

## Introduction

Water is an essential factor for the survival of all living organisms. Water exists in three states, liquid, solid (ice) and gas (steam). Water occupies 75% of the earth's surface in the form of oceans and other large water bodies. Salt water occupies 97% of surface water followed by polar ice glaciers of 2.4% and remaining 0.6% was freshwater comprising rivers, lakes, etc. Water is considered as a wonderful chemical possessing diverse range of microorganisms and unique properties of dissolving various chemicals (Scragg, 2005). Due to the urbanization, toxic chemical contamination to freshwater ecosystem is a serious problem threatening the various life forms depending on it. The term detergent commonly referred towards the combination of various surface-active agents (surfactants) used for the removal of foreign matter from solid surfaces and retaining it in suspension (Ying, 2006). All the major commercial cleaning products are comprised of surfactants followed by builders, which enhances the cleaning efficiency and reduces the water hardness. The other ingredients of cleaning products include stabilizers, whiteners, bleaching agents, bactericidal agents, fragrances, enzymes, etc.

Based on ionic properties, surfactants can be classified into anionic, cationic and non-ionic. Generally laundry detergents, household and personal cleansing products belong to anionic detergents. Automatic dishwasher and rinse aids come under nonionic surfactants and most widely used nonionic surfactants are alcohol ethoxylates. The fabric softeners, disinfectants,

sanitizers and in fabric-softening laundry detergents belongs to cationic detergents. The surfactant used in household and industries are mostly discharged into environment which leds to several ill effects (Peterson, 1998; Thakur and ShekharIndu, 2006). The microorganism inhabited to such contaminated sites might develop the resistance mechanism for their survival and also few might possess ability to degrade such contaminants (Frayal Rani and Hammed Abdul, 2005). Hence, in the present investigation, detergent degrading ability of the series of fungi isolated from a local freshwater ecosystem, Manjakkudi lake was evaluated.

## Materials and Methods

### *Study area and Sample collection*

The study area Manjakkudi village is located in the Pudukkottai district of Tamil Nadu, India. The population of the village is about 1442 and depends on Manjakkudi lake for drinking water resource. The one meter deep water samples were collected from Manjakkudi lake in a sterile plastic bags. The water samples collected were kept at room temperature and transferred to the laboratory and processed.

### *Isolation of fungi*

About 1 ml of the water sample was diluted in 99 mL of sterilized distilled water; 0.1 mL of the suspension was spreadonto Petri dishes containing Potato Dextrose Agar (DA) amended with 500 mg/L chloramphenicol. The plates were allowed to incubate at 28 °C for 4 days. The colonies developed were transferred separately to PDA plates for purification. After checking the purity of the fungal colonies, they were again sub-cultured onto Potato Dextrose Agar plates.

### *Identification of fungi*

The macroscopic and microscopic identification of the fungi was carried out by microculture on a microscope glass slide (Raper and Thorn, 1949; Raper and Fennell, 1965; Barnett and Hunter, 1986; Subramanian, 1971; Ainsworth et al., 1973; Domsch et al., 1980; Van der Plaats-Niterink, 1981; Stolk and Samson, 1983; Schipper, 1984).

### *Detergents*

The detergents used in the present investigation were household synthetic detergent of Ariel and Surf excel brands.

### *Detergent degradation*

The experimental fungi were separately inoculated into the flasks that contained chemically-defined microbial growth medium and the detergent to be tested. The growth medium consists of: 3 g $NaNO_3$, 1 g $K_2HPO_4$, 1 g $MgSO_4$, 0.25 g $MgSO_4.7H_2O$, 0.01 g $FeSO_4.7H_2O$ and 1 g of detergent. The flasks were incubated for 4 days. The optical density of the medium was recorded at 510 nm after 4 days incubation. The same setup without fungal inoculation served as control (Amiy Dutt Chaturvedi and Tiwari, 2013). The percentage detergent degradation was calculated using the formula:

$$\text{Percentage degradation \%} = \frac{\text{Control OD - Test OD}}{\text{Control OD}} \times 100$$

## Results and Discussion

In the present investigation, the freshwater ecosystem was gained attention as they were getting polluted every day by both domestic and industrial wastewaters (Chaturvedi and Kumar, 2010). It is necessary to find a way to remove pollution from the lakes as they serve as drinking water resources for nearby villages. Due to lack of sufficient research works, there is a delay in the establishment of efficient methods for their bioremediation. Of the household waste, detergent components served as serious problems as they affect the aquatic life forms including alage, and fishes (Peterson et al., 2000). Microbial biodegradation serves as a suitable method for the degradation of detergent components such as surfactants. The fungi were previously explored by many researchers to degrade water contaminants including cellulose (Thakur and Shekhar, 2006), SDS (Abboud et al., 2007) and other detergent components. The fungi are also used in the recycling of municipal solid waste.

Against these backdrops, the fungi were isolated from the water samples collected from Manjakkudi lake. From the samples, a total of nine fungi were isolated. The isolated fungi were purified and subcultured in PDA plates. Based on the morphological characterization, the isolated fungi were identified as *Aspergillus flavipes, Aspergillus nidulans, Penicillium citrinum, Penicillium piceum, Trichoderma viride, Rhizopus arrhizus, Mucor luteus, Fusarium oxysporum* and *Curvularia lunata*.

The ability of the fungal strains in the degradation of commercial detergents was evaluated further. For the purpose, monosporial cultures of the fungi isolated from the Manjakkudi lake were used. The results of the detergent degradation study revealed that each species of fungi recorded differential rate of degradation to each detergent (Table 1). Nevertheless, among the various fungi, *M. luteus* appeared to degrade both the detergents at almost the same rate (58.33% for Ariel and 54.29% for Surf excel). The differences in degradation noticed among the two detergents as well as the differential rates of degradation shown by the fungi may be attributed to the differences in the rate of enzyme activities as well as differences in the composition of the two detergents.

**Table 1: Detergent degradation using freshwater fungi isolated from Manjakkudi lake**

| S. No. | Species | Name of the detergent (1 g/l) | Percentage degradation (%) |
|---|---|---|---|
| **1.** | *Aspergillus flavipes* | Aerial | 47.20 |
| | | Surf Excel | 48.38 |
| **2.** | *Aspergillus nidulans* | Aerial | 57.14 |
| | | Surf Excel | 63.63 |
| **3.** | *Penicillium citrinum* | Aerial | 50.00 |
| | | Surf Excel | 48.00 |
| **4.** | *Penicillium piceum* | Aerial | 35.89 |
| | | Surf Excel | 42.50 |
| **5.** | *Trichoderma viride* | Aerial | 39.39 |
| | | Surf Excel | 41.18 |
| **6.** | *Rhizopus arrhizus* | Aerial | 56.72 |
| | | Surf Excel | 50.00 |
| **7.** | *Mucor luteus* | Aerial | 58.33 |
| | | Surf Excel | 54.29 |
| **8.** | *Fusarium oxysporum* | Aerial | 41.38 |
| | | Surf Excel | 47.00 |
| **9.** | *Curvularia lunata* | Aerial | 65.38 |

Similar to our study, Ojo et al. (2009) evaluated the ability of bacteria and fungi to degrade the detergents from the effluents of textile industries. In the present study, *M. luteus* efficiently degrade both the commercial detergents. Choudhury (2008) analyzed the scientific mechanism behind the microbial utilization of detergents and explored their application in fish production using treated water. During recent years, there is an attention paid by the researchers towards the investigation of commercial detergents for the presence of toxic components and their effect on aquatic life forms upon discharging. Studies were also started with respect to the biodegradation of detergents and heavy metals present in the aquatic ecosystem and further need to be explored more.

## Conclusion

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 fungi isolated from the freshwater ecosystem, Manjakkudi lake were evaluated for the degradation of commercial detergents, Ariel and Surf excel. 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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