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# Bioremediation of Detergents Using Fungi Isolated from a Fresh Water Pond in Tamil Nadu, India.

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## Abstract
Detergents are widely used throughout the world in both industrial and domestic premises for washing various materials. They are also used in pesticide formulations for dispensing oil spills in sea. However, in aquatic systems they can cause extensive damage to organisms. Various microorganisms including fungi have an ability to degrade detergents. Hence the present study was attempted in analyzing the biodegradability of detergents using five species of fungi. Results indicate that biodegradability of detergents ranged between 62.40 and 82.10% for Surf Excel and 54.20 and 70.24% for Challenge. Among the various fungi, *Aspergillrs terreus* recorded highest degradability and *Fusarium oxysporum* the lowest degradability for both the detergents. Nevertheless, the study clearly reveals that fungi has the ability to degrade detergents atleast at different levels.

**Keywords**
Fresh water, detergents, bioremediation, fungi.

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**INTRODUCTION:**
Detergents are organic compounds which have both polar and non-polar characteristics. They tend to exist at phase boundaries where they are associated with both polar and non-polar media (Wemedo and Nrior, 2017). There are two types of detergents with different characteristics – Phosphate detergents and surfactant detergents. Detergents that contain phosphate are highly caustic (Wemedo and Nrior, 2017). Surfactant is an abbreviation of a surface-active agent that *refers* to its ability to reduce the interfacial tension between two phases *(*Stojanovic *et al*., 2011). This behavior is caused by the molecular composition in the surfactant which has a hydrophilic part composed of alkyl chains and another part that is anionic or hydrophilic group (Lopez-Mahia *et al*., 2005).
Detergents are widely used throughout the world in both industrial and domestic premises for washing various kinds of materials. In addition, they are also used in pesticide formulations for dispensing oil spills in *Sea* (Wemedo and Nrior, 2017). The major entry of detergents into the aquatic system is through sewage. Once in the aquatic system, they can have deleterious effects on the organisms that live there (Lenntech, 2008). All detergents destroy the external mucus layer of fishes and cause severe damage to gills, damage eggs and even the breeding ability of fishes and can even cause mortality if present in large quantities (Obire and Nirior, 2014). In addition,

phosphates in detergents can lead to algal bloom that release toxins and decrease oxygen uptake (Wemedo and Nrior, 2017).

India, with its vast population, is experiences a surge in the use of detergents. This will lead to an increase in their concentrations in aquatic systems there by endangers the existence of organisms living there. Hence there has been an urgent need to solve this problem. Hence there has been many studies using microorganisms to biodegrade the detergents in their aquatic systems. Many workers (Sanz *et al*., 2003; Boninu *et al*., 2004; Balson and Felix, 1995, Stojanovitic *et al*., 2011) have suggested that fungi are excellent candidates for biodegradation of detergents. Hence the present study was carried out to analyse the effect of biodegradation of various detergents uses the commonly occuring fungi in the fresh waters of this region.

## MATERIALS AND METHODS

**Study Area and Sample Collection**:

The study area of Kulumani village is located in the Tiruchirappalli District of Tamil Nadu, India. The population of the village is about 1060 and depends on Kulumani pond for general water resource. 50 cm deep water samples were collected from Kulumani pond in a sterile plastic bag. 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 spread onto 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 micro culture 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 Challenge and Surf Excel.

**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 consisted of 3 g NaNO3, 1g K2HPO4, 1 g MgSO4, 0.25 g MgSO4.7H2O, 0.01 g FeSO4.7H2O and 1 g of detergent. The flasks were incubated for 4 days. The optical density of the medium was recorded at 510 nm after four 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:

**Percentage Degradation = Control OD – Test OD/ Control OD × 100**

## RESULT DISCUSSION

The bioremediation of detergents using the various fungi are presented in Table 1. As evident from the table, all the five species of fungi. Used in the present study were able to degrade the detergents that were used. However, as seen from the table, the efficiency of degradation was found to vary from species to species.

With regard to the detergent Surf Excel, the percentage of degradation was found to range between 62.40 and 82.10% while the maximum degradation was noticed in the fungi *Aspergillus terreus* followed by the minimum degradation was recorded in *Fusarium oxysporum* with the other two species *Asporgillus oryzae* (76.44%) and *Penicillium funiculocum* (79.41%) showing in between levels of degradation.

With regard to the second detergent “Challenge”, the degradation levels ranged between 54.20 and 70.24%. While the highest degradation rate was shown by *A. terreus* closely followed by *R.stolonifer* the lowest levels of degradation was noticed with *F. oxysporum* with *Penicillium funiculocum* (74.2%) and *Aspergillus oryzae* (66.23%) showing in between levels of degradation.

The results of the present study clearly show that each species of fungi showed different levels of degradation with different detergents. Nevertheless, a closer perusal of the table shows that *A. terreus* recorded maximum levels of degradation for both the detergent used. However, while the degtradation levels for Surf Excel was higher (82.10%) when compared to the degradation levels of Challenge (70.24%). Among all the fungi used,

degradation levels of *F. oxysporum* was lowest to both the detergents.

A perusal of literature reveals that Benila smily (2017) while studying the effect of bioremediation of detergents recorded degradation levels ranging from 42.50 to 63.63% for the detergent 'Surf Excel', with *Aspergillus nidulans* regarding the highest degradation and *Mucor luteus* recording the lowest degradation. A comparison of the degradation levels with that of the present study reveals that higher degradation levels could be achieved in the present study. Thus, it appears that *A. terreus* appears to be a better candidate than *A. nidulans.*

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. A similar observation was also noticed by Benila smily (2017) and Ojo obusola and OSa Benjamin (2009) suggested the temperature range of 33-34$^0$ C was supportive for metabolic activities of microbes and neutral P$^H$ leads to degradation of detergents, However, Kalpana Devi *et al.* (2008) observed that alkaline protease isolated from *Aspergillus* niger tested with different detergents could induce production of surfactant beneficiate to laundry industries. While Ojo Obusola and OSo Benjamin (2009) also reported that detergents used in could be degraded fungi. Stojanovic (2011) reported that the degradation of detergents depends on the metabolic activity of fungi. Thus, the present study clearly suggests that the fungi used in the present study have the ability to degrade detergents at least at different levels.

**Table: 1 Detergent powders degradation using selected fungal sepsis Isolated from a Freshwater pond at Kulumani, Tamil Nadu.**

| | Fungal sepsis | Name of the detergent powder | OD value of unknown sample with detergent 510 nm | OD value of unknown sample with detergent 510 nm | Percentage degradation |
|---|---|---|---|---|---|
| 1 | *Aspergillus niger* | Surf Excel | 0.65 | 0.48 | 76.64 |
| | | Challenge | 0.64 | 0.34 | 66.23 |
| 2 | *Penicilium funiculosum* | Surf Excel | 0.72 | 0.54 | 79.41 |
| | | Challenge | 0.58 | 0.39 | 64.20 |
| 3 | *Aspegilus terreus* | Surf Excel | 0.64 | 0.41 | 82.10 |
| | | Challenge | 0.68 | 0.52 | 70.24 |
| 4 | *Rhigopus stolanifer* | Surf Excel | 0.72 | 0.38 | 80.18 |
| | | Challenge | 0.62 | 0.42 | 69.28 |
| 5 | *Fusaium oxysporum* | Surf Excel | 0.78 | 0.40 | 62.40 |
| | | Challenge | 0.64 | 0.48 | 54.20 |

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