BIOREMEDIATION OF DETERGENTS USING LIMNOFUNGI

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ABSTRACT *Eventhough surfactants are essentially non-toxic to man at the concentrations likely to be met in wastewaters there is a wide agreement that their presence in aquatic systems in undesirable.Hence the present study was attempted using commonly available fungi in the degradation of detergents that are commonly used in this region.With regard to Acremonium strictum, thedegrading ability of the three detergents analysed was almost the same (Tide plus 58.92%, Surf Excel 58.33% and Challenge DP 58%). Fusarium oxysporum, on the other hand, recorded the maximum degrading ability with Tide (60.1%) followed Surf (58.33%) and Challenge (42.1%). Mucor luteus, on the other hand recorded greatest degrading ability with Tide (48.48%) followed by Challenge (39.47%) and Surf (35.89%). Cryptococcus neoformans, however, recorded highest degrading ability with challenge (60.52%) followed by Tide (52.63%) and Surf (48.83%) while Aspergillus niger recorded the highest degradability with Tide (56.25%) and equal degradability with Surf and Challenge. Penicillium funiculum, nevertheless recorded highest degradability with Tide (91.17%) followed by Challenge (80.1%) and Surf (74.35%). Thus, the present study shows differential degradability to different detergents by all the fungi.*

Keywords: *Fresh water, fungi, Bioremediation, detergents*

1. INTRODUCTION

Water is an essential factor for the survival of all living organisms. Due to urbanization, chemical contamination of fresh water ecosystems has become a serious problem threatening the various life forms depending on it (BenilaSmily and Sumithra, 2016). Among the various contaminants, the use of detergents have reached alarming proportions. Detergents are formulations designed to have cleaning / solubilization properties which consist of surface-active reagents (surfactants) together with subsidiary components including builders (Stoanovic*et al.*, 2011). As detergents have both polar and non-polar characteristics and tend to exist at phase boundaries where they are associated with both polar and non-polar media (Wemedo and Nrior, 2017). Further detergents that contain phosphate are highly caustic and surfactant detergents are toxic. Detergents including biodegradable detergents have poisonous effects in all types of aquatic life if they are present in sufficient quantities (Lenntech, 2008).

Even though surfactants are essentially non-toxic to man at the concentrations likely to be met in wastewaters there is a wide agreement that their presence in aquatic systems in undesirable (Stojanovic*et al.*, 2011). Recent developments (Stojanovic*et al.*, 2011; BenilaSmily and Sumithra, 2016; Wemedo and Nrior, 2017) have shown that microorganisms especially fungi have got the ability to degrade detergents. Hence the present study was attempted using commonly available fungi in the degradation of detergents that are commonly used in this region.

2. MATERIALS AND METHODS

Study Area and Sample Collection: The study area,Asurvillage is located in theKumbakonamTaluk, ThanjavurDistrict,Tamil Nadu, India. Thepopulation of the village is about 1060 and depends onAsur pond for general water resource. Fifty centimeter deep water samples were collected fromAsur pond in a sterile plastic bag. The watersamples collected were kept at room temperature andtransferred to the laboratory and processed.

Isolation of Fungi:About 1 ml of the water sample was diluted in 99 mlof sterilized distilled water; 0.1 mL of the suspensionwas spreadonto Petri dishes containing PotatoDextrose Agar (DA) amended with 500 mg/l chloramphenicol. The plates were allowed to incubateat 28 °C for 4 days. The colonies developed weretransferred separately to PDA plates for purification.After checking the purity of the fungal colonies, theywere again sub-cultured onto Potato Dextrose Agarplates.

Identification of Fungi: The macroscopic and microscopic identification of thefungi was carried out by microculture on a microscopeglass slide (Raper and Thorn, 1949; Raper andFennell, 1965; Barnett and Hunter, 1986;Subramanian, 1971; Ainsworth *et al*., 1973; Domsch*et al*., 1980; Van der Plaats-Niterink, 1981; Stolk andSamson, 1983; Schipper, 1984).

Detergents: The detergents used in the present investigation werehousehold synthetic detergent of

Challenge, Tide Plus and Surf Excel.

Detergent Degradation: The experimental fungi were separately inoculatedinto the flasks that contained chemically-definedmicrobial growth medium and the detergent to betested. The growth medium consists of: 3 g $NaNO_3$, 1gK_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 wereincubated for 4 days. The optical density of themedium was recorded at 510 nm after four daysincubation. The same setup without fungal inoculationserved as control (AmiyDutt Chaturvedi and Tiwari,2013). The percentage detergent degradation wascalculated using the formula:

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

3. RESULTS AND DISCUSSION

The results of the degrading ability of the various fungi collected from the systems is presented in Table-1. As evident from the table, it is clear that the fungi chosen for the present study has the ability to degrade detergents.

With regard to *Acremonium strictum*, thedegrading ability of the three detergents analysed was almost the same (Tide plus 58.92%, Surf Excel 58.33% and Challenge DP 58%). *Fusarium oxysporum,* on the other hand, recorded the maximum degrading ability with Tide (60.1%) followed Surf (58.33%) and Challenge (42.1%). *Mucorluteus*, on the other hand recorded greatest degrading ability with Tide (48.48%) followed by Challenge (39.47%) and Surf (35.89%). *Cryptococcus neoformans*, however, recorded highest degrading ability with challenge (60.52%) followed by Tide (52.63%) and Surf (48.83%) while *Aspergillus niger* recorded thehighest degradability with Tide (56.25%) and equal degradability with Surf and Challenge. *Penicillium funiculum,* nevertheless recorded highest degradability with Tide (91.17%) followed by Challenge (80.1%) and Surf (74.35%). Thus, the present study shows differential degradability to different detergents by all the fungi.

A comparison of the degrading ability of the present study with that of others reveals that BenilaSmily and Sumithra (2016) recorded a percentage degradation of 54.29 (Surf) by *M. luteus*, 47% by *F. oxysporum*, 48% by *A. flavipes*and 42.5% by *P. piceum*. In the present study, *Fusarium* and *Penicillium* recorded higher degrading abilities while *Aspergillus* recorded almost similar degrading ability and *Mucor* recorded lower degrading ability. The differences noticed in the degradation noticed among the various detergents as well as the differential rates of degradation shown by the different fungi can be attributed to the differences in the rate of enzyme activities as well as to the differences in the composition of the detergents as opined by BenilaSmilyand Sumithra (2016) and Stojanovic*et al.* (2011). In addition, the variation in the physico-chemical variables and their ability to interact among themselves could also result in producing metabolic changes in these organisms (Nrior and Odokuma, 2015; Wemedo and Nrior, 2017).

In the present study, among the various fungi analysed, the highest percentage degradability was shown by *Penicillium* to all the three detergents analysed, while *Cryptococcus* recorded the second highest degradability for Challenge, *Acremonium* and *Fusarium* recorded the second highest degradability for Surf while *Fusarium* in addition also showed the second highest degradability for Tide. In the present study among all the fungi analysed, *Mucor* recorded the lowest degradability to all the three detergents.

The results of the present study clearly indicate that *P. fumicularium* which is a commonly occurring species in the aquatic system of this region can be used as a candidate species for metabolizing detergents and play an important role in the purification of aquatic systems.Table-1

Detergents powders degradation using fungal species isolated from Fresh water Pond

Species	Name of the Detergent Powder	OD of unknown sample with detergent at 510 nm	OD of known sample with detergent at 510 nm	Percentage degradation
Acremonium strictum	Challenge	0.62	0.36	58.00
	Tide Plus	0.56	0.33	58.92
	Surf Excel	0.72	0.42	58.33
Fusarium oxysporum	Challenge	0.76	0.32	42.10
	Tide Plus	0.60	0.36	60.10
	Surf Excel	0.72	0.42	58.33

Species	Name of the Detergent Powder	OD of unknown sample with detergent at 510 nm	OD of known sample with detergent at 510 nm	Percentage degradation
Mucor luteus	Challenge	0.80	0.30	39.47
	Tide Plus	0.66	0.32	48.48
	Surf Excel	0.78	0.26	35.89
Cryptococcus neoformans	Challenge	0.76	0.46	60.52
	Tide Plus	0.76	0.40	52.63
	Surf Excel	0.86	0.42	48.83
Aspergillus niger	Challenge	0.72	0.36	50.03
	Tide Plus	0.64	0.36	56.25
	Surf Excel	0.88	0.44	50.20
Penicillium funiculum	Challenge	0.75	0.60	80.00
	Tide Plus	0.68	0.62	91.17
	Surf Excel	0.78	0.58	74.35

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