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Effect of Household detergents (Surfactants) Degraded through aquatic fungi

Amiy Dutt Chaturvedi¹ and K.L. Tiwari²

¹Department of Biotechnology, S.S.M.V Sec-6 Bhilai, India.

²Department of Biotechnology, G.G.U Bilaspur (Chhattisgarh), India

Abstract

Commercial household detergents are diverse group of chemical that is best known for their wide used in laundry industries and household cleaning product. After use, residuals (Surfactant) detergents are discharge into sewage system directly or indirectly into the surface water and most of them end up dispersed into the different environment compartment of soil and water. Water is facing lots of problems due to domestic waste. These toxic effects of surfactant damaging biodiversity of aquatic environment. Most of aquatic microorganism develops a bio-mechanism for degradation of harmful heavy metals discharge in water at high level. As we know that aquatic environment specially water "fungi" have excellent potential for metal accumulation, particularly genera of *Rhizopus*, *Aspergillus*, *Streptovorticillum*, *Sacchromyctes*. In general most of commercial household (Surfactants) detergents are biodegradable and amount of it can be commercially reduced by secondary treatment of Municipal sewage waste water plants. These discharge waste water pollutants with massive quantities especially surfactant could be a serious threat to aquatic ecosystem. Future studies of Commercial Surfactant toxicities and biodegradation are necessary to withdraw high toxic and non-biodegradable heavy metal for commercial use as a result makes an eco-friendly environment.

Keywords: Biodegradation, Surfactant Toxicity, Heavy metals, Municipal sewage waste.

INTRODUCTION

Water is a common chemical substance that is essential for the survival of all known forms of life. In typical usage, water refers only to its liquid form or state, but the substance also has a solid state, ice, and a gaseous state, water vapor or steam. Water covers 75% of the earth's surface on earth, it is found mostly in oceans and other large water bodies, with 1.6% of water below ground in aquifers and 0.001% in the air as vapor, clouds (formed of solid and liquid water particles suspended in air), and precipitation. Saltwater oceans hold 97% of surface water, glaciers and polar ice caps 2.4%, and other land surface water such as rivers, lakes and ponds 0.6%. A very small amount of the earth's water is contained within biological bodies and manufactured products. Other water is trapped in ice caps, glaciers, aquifers, or in lakes, sometimes providing fresh water for life on land. Water is one of the most important constituents life supported system. It is indeed a wonderful chemical medium which have a unique properties of dissolving and carrying in suspension huge varieties of chemicals as well as many microorganism also completing life cycle in water Santra (2001). 'WATER' is facing lot of problems so called development of human prior to about 1940, as industrial development, the amount of heavy metals and synthesized organic compounds generated by industrial activities has increased, and some 10,000 new organic compounds are added each year. Many of these compounds are now found in wastewater from most municipalities and communities waste Metcalf and eddy (2004). Due to the scientific and technological progress, toxic metal contamination is a serious problem threatening human health for example, copper ions can damage kidneys and the liver, causing anemia such as Pb^{II}, Cd^{II}, Hg^{II}, and Ni^{II} and Synthetic detergents are toxic and carcinogenic at even relatively low concentrations. They are not biodegradable and can accumulate in living organisms. Therefore, these heavy metals can be considered as one of the most important pollutants for waters and waste waters. Heavy metals are

generally discharged to the environments via automobile emissions, mining activities, battery industry, fossil fuels, metal plating and electronic industries with diverse routes. In order to remove heavy metal from various environmental source. Heavy metal ions are harmful and toxic to human beings. Therefore, they must be removed from wastewater and drinking water.

Water is often believed to have spiritual powers. In Celtic mythology, Sulis is the local goddess of thermal springs; in Hinduism, the Ganges is also personified as a goddess, while Saraswati have been referred to as goddess in Vedas. Also water is one of the "Panch-Tatva" (basic 5 elements, others including fire, earth, space, air). Alternatively, gods can be patrons of particular springs, rivers, or lakes: for example in Greek and Roman mythology, Peneus was a river god, one of the three thousand ocean side. In Islam, not only does water give life, but every life is itself made of water. This natural resource is becoming scarcer in certain places, and its availability is a major social and economic concern. Currently, about 1 billion people around the world routinely drink unhealthy water. Most countries accepted the goal of halving by 2015 the number of people worldwide who do not have access to safe water and sanitation. Even if this difficult goal is met, it will still leave more than an estimated half a billion people without access to safe drinking water and over 1 billion without access to adequate sanitation. Poor water quality and bad sanitation are deadly; some 5 million deaths every year are caused by polluted drinking water. World Health Organization (WHO) estimates that safe water could prevent 1.4 million child deaths from diarrhea each year. Water, however, is not a finite resource, but rather re-circulated as potable water in precipitation in quantities many degrees of magnitude higher than human consumption. Therefore, it is relatively small quantity of water in reserve in the earth (about 1% of our drinking water supply, which is replenished in aquifers around every 1 to 10 years), that is a non-renewable resource, and it is, rather, the distribution of potable

and irrigation water which is scarce, rather than the actual amount of it that exists on the earth. Water-poor countries use importation of goods as the primary method of importing water (to leave enough for local human consumption), since the manufacturing process uses around 10 to 100 times products' masses in water. Water pollution is the contamination of water bodies such as lakes, rivers, pond, oceans, and groundwater caused by human activities, which are harmful to organisms and plants that live in these water bodies. Water pollution is a major problem in the global context. It has been suggested that it is the leading worldwide cause of deaths and diseases, and that it accounts for the death of more than 14,000 people daily. In addition to the acute problems of water pollution in developing countries, industrialized countries continue to struggle with pollution problems as well. In the most recent national report on water quality in the United States, 45 percent of assessed streammiles, 47 percent of assessed lake acres, and 32 percent of assessed bay and estuarinesquare miles were classified as polluted. Water is typically referred to as polluted when it is impaired by anthropogenic contaminants and either does not support a human use, like serving as drinking water, and/or undergoes a marked shift in its ability to support its constituent biotic communities, such as fish. Natural phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water. Water pollution has many causes and characteristics. In the developing world, 90% of all wastewater still goes untreated into local rivers and streams. Some 50 countries, with roughly a third of the world's population, also suffer from medium or high water stress, and 17 of these extract more water annually than is recharged through their natural water cycles. The strain not only affects surface freshwater bodies like rivers and lakes, but it also degrades groundwater resources.

Surfactant in Environment

Detergents are various surface-active agents (surfactants) particularly effective in dislodging foreign matter from solid surfaces and retaining it in suspension. Soap, which is made from fats or fatty acids, is a detergent. However, in common usage the term 'detergent' applies to the synthetic non soap substances, not to soap, and also to products made from synthetic surfactants. Surfactants and builders are the major components of cleaning products, with the builders serving to enhance or maintain the cleaning efficiency of the surfactants, primarily by reducing the water hardness. Other ingredients are added to formulations to provide functions such as increasing cleaning performance for specific soils/surfaces, ensuring product stability, and supplying a unique identity to a product. Examples include foam stabilizers, optical brighteners or whiteners, anti-redeposition agents, bleaching agents (chlorine-releasing agents) or bactericidal agents (mild concentrations of quaternary ammonium compounds), enzymes, fragrances, and dyes. Water is likely to be the major component of a liquid version of a detergent product.

Surfactants are usually classified by their ionic properties in water. Anionic surfactants are used in laundry and hand dishwashing detergents, household cleaners, and personal cleansing products. Linear alkylbenzenesulfonate, alcohol ethoxysulfates, alkyl sulfates, and soap are common anionic surfactants. Nonionic surfactants are low sudsing, and are typically used in laundry and automatic dishwasher and rinse aids. The most widely used nonionic surfactants are alcohol ethoxylates. Cationic surfactants are used in

fabric softeners and in fabric-softening laundry detergents. Other cationic are the disinfecting/sanitizing ingredients used in some household cleaners. Quaternary ammonium compounds are the major cationic surfactants. Amphoteric surfactants are used in personal cleansing and household cleaning products for their mildness, sudsing, and stability. Imidazolines and betaines are major amphoteric surfactants. Surfactants (surface-active agent) are diverse and amphiphilic compounds which can reduce surface and interfacial tensions by accumulating at the interface of immiscible fluids and increase the solubility, mobility, bioavailability and subsequent biodegradation of hydrophobic or insoluble organic compounds. Surfactants are best known for solubility of cleaning properties which secured them a place of detergent and other cleaning product Ying (2006). Massive quantities of surfactant are being used in household and industries every day and most end up dispersed in different environment compartment (Soil, Water and Sedimentation). More than 4.2 million tones of detergent product and million tones of soften detergent product and 1.2 million tons were used annually in Western Europe ten year ago Peterson *et al.* (2000). Edser (2006) reported that worldwide production of surfactant rise to 12.6 million tones in 2000. No doubt they are surface chemically synthesized surfactants are commonly used in the petroleum, food and pharmaceutical industries as emulsifiers and wetting agents. Bio-surfactants produced by some microorganisms are becoming important biotechnology products for industrial and medical applications. Cain (2004) observed that research is required to understand the genetic basic of bacteria surfactant resistance to surfactant and distinguish bacterial lysis by contributing rational development in turnover of surfactant. Biodegradation are evaluated and monitored by river water "die-away" method by containing methylene blue active substances (MBAS). While SDS and three other commercial detergents were degraded in 21 days or less, two persisted for 28 days or more. One of them was only 45% degraded in 32 days. Toshijuki Oyama *et al.* (2004) focused work on phytodegradation of *Tio* in presence of sunlight have effective use in irrigation and can detoxify wastewater containing detergents. Major consistent affect the organ are APE type of surfactant. Mam and Bidwell (2004) observed that Australia frog larval stage (tadpool) are effected by A.E nonyl phenol surfactant are acute ecotoxicans also observed dye Pollution is the major cause of Egyptian textile industries, fungal agents are best source for removable of dye waste. Another possible cause of a reduced rate of bioremediation in the presence of surfactant is due to increased toxicity of the hydrophobic contaminant due to its increased (pseudo) solubility. Surfactants increase the apparent aqueous solubility of hydrophobic substrates. Toxicity testing indicated that the presence of solubilized phenanthrene increased the toxicity of the surfactant by a 100 fold Shin *et al.* (2005).

Banger and Kapoor (2005) observed that heavy metal can be bioremediated from pollutant sites. Ulfig (2005) observed pathogen like microorganism and pathogen fungi present in sewage sludge waste have a greater possibility of damaging the human health and can be decreased by Geophilic Delmetophytes and Kerlinolytic fungi. Emtaizet *et al.* (2005) observed animal residues biodegraded by two important fungi's *T. reesei*, *A. terreus* feeding on weed straw can be digestive by plant residue. Faryal (2005) observed that industrial effluents can be bioremediated by water fungi by determining physiochemical parameter. Another possible cause of a reduced rate of bioremediation in the presence of surfactant is due to increased toxicity of the hydrophobic contaminant due to its increased (pseudo)

solubility. Surfactants increase the apparent aqueous solubility of hydrophobic substrates. Toxicity testing indicated that the presence of solubilized phenanthrene increased the toxicity of the surfactant by a 100-fold. (Shin *et al.*, 2005; DhoubiElliouzet *al.* 2005) observed that potential in *Phanerochaete chrysosporium* whit- rot fungi to detoxify the oil mill waste to activate aerobic and anaerobic use in biogas. Cain (2005) observed that surfactant can be biodegradable with waste stream damages aquatic environment. Scragg (2005) investigated that fungi's can biodegradation surfactants present in pond water and microorganisms have higher rate in degrading pollutants. Yangi (2006) observed that surfactant can be degradable through microbe. Mandic (2006) observed that microbial growth at different concentration of detergent. Malik *et al.* (2005) observed that nitrogen fixing bacteria *Glycospira* were inhibited by presence of SDS also in sewage isolated *Acinetobacter joshii* and *Oligotrophacarboidovoranas*.

Faeaponauvaet *al.* (2006) observed those anions surfactants SDS (Sodium-dodecylsulphate) are toxic for aquatic species like algae, crustacean, echinodermata and fishes. Bacteria species *Vibrio fischeri* have more sensitive to remove SDS. Thakur (2006) observed that more than 14000 fungi are recognized for cellulose degradation in water. Fijanet *al.* (2006) focused on the need of food hygiene and precaution for commercial use of laundry products to reduce microbial growth in food industry. Singh and Tyagi (2006) observed the pH level of surfactant are dependent on cationic and anionic behavior of Zwitterions reduced its intermediate compounds of fungal metabolism. Shukoret *al.* (2007) have isolated a strain belonging to *Klebsiella oxytoca* which could degrade 1g/l SDS in 72 h incubation times. The rate of degradation of SDS by this isolate is very low as compared to our isolates. Abboudet *al.* (2007) notably biodegradation of SDS by facultative anaerobic bacteria is of rare occurrence. Saojanovicet *al.* (2007) observed enzymatic activities of some fungal species could reduce the biomass by accumulating detergents. Jones (2007) observed that biosurfactants have potential of bioavailability through microorganism which bioremediated because they do not accumulate in environment and have low toxicity for adequate organism growth. Toumelaet *al.* (2000) observed that municipal solid waste comes from household can be recycled. Peclulyte, (2007) observed recycle of Plants pulp (Cartoon) waste paper mills which has cellulose and fungi's are isolated from Cellulotic pulp of waste have better impact on paper production gives economical importance of paper Industries. Schowaneket *al.* (2007) Some fungi *Aspergillus niger*, *Acremonium murorum* were selected, but in spite of these the best result is obtain from *Trichoderma* have probability of reducing LAS as a commercial product isolated from agriculture waste. Yan and Tyagi (2007) observed traditional microbial product from (WWS) composed of methane and studied product value of biopesticides inoculation in microbiology enzyme for industrial use have great concern over green house gases. Constantia, Stametelatus, Kornaros and lyberatos (2007) observed Xenobiotic compound (LAS) liner alkyl benzene sulphate can be biodegradable from aerobic microbial consortium to accumulating its temporal. Ojoet *al.* (2008) studied Mesophilic temperature range (33.9-34.°C) was found to be supportive for metabolism activities of microbes and due to alkaline pH shifted to normal level that is why detergents are degraded and observed on toxicity of surfactant affected on plants present in water. Palaniswamyet *al.* (2008) observed alkaline protease isolated from *Aspergillus niger* tested on different commercial detergents like Tide, Surf, Wheel, Henko could induce production of Surfactant beneficial

to laundry industries. Choudhury (2008) focused on understand Scientific mechanism behind waste water purification for utilization irrigation and fish production to explore the microbial diversity in ecosystem for bioremediation and Biotechnology use. Smith *et al.* (2008) observed Surfactant toxicity in bacteria and aquatic organism such as invertebrate or fish have anti-oxidation properties such as QAS detected from its antibacterial properties. QAS is used in health care and disinfection product. Ojoet *al.* (2009) observed biodegradation of detergents from waste water of textile and pharmaceutical Industries through bacteria and fungi. O Fasidiet *al.* (2009) observed different whit-rot fungi for degrading lignin as a way for bioremediation from agro-waste which cause harm to environment. Ivankovic and Hrenovic (2009) Review there studies on surfactant toxicity and biodegradation by replacing them with non-biodegradation compound for commercial use and observed on four different sites of oil refinery; that detergents can reduce refinery waste up to 40% by core flooded. Fungi play an important role in food-chain and food-web of ecosystem. Due to widespread use of SDS in households and industry followed by its subsequent disposal in waterways, there is apprehension of alarming consequences on various living organisms Chaturvedi and Kumar (2010). In fungal degradation many scientists have studied various points of view and concluded that detergents are harmful for aquatic ecosystem. From the above discussion it is clear that in India need to have numerous investigations for the commercial detergents present in the market for external use however, in India it was some how started by few works on biodegradation and bioremediation of heavy metal and commercial product discharge in water. Husseinet *al.* (2011) has isolated two bacterial strains from activated sludge. These isolates were identified as *Pseudomonas betelli* and *Acinetobacter johnsoni* respectively. It was observed that these strains degraded 522 mg/L of SDS to the extent of 93.6% and 84.6% within 5 days respectively. Biodegradation of SDS was also reported by consortia of *Acinetobacter calcoaceticus* and *Pantoea agglomerans*.

MATERIALS AND METHODS.

- Isolation of fungi from domestic wastewater (Detergent rich water).
- Determine the dominated fungi

Calculation

$$\text{Percentage contribution} = \frac{\text{Total no. of colonies of a species in all observation taken together}}{\text{Total no. of colonies of all species}} \times 100$$

- Effects of detergents on dominated fungi on the basis of fungal biomass.
- Detergent degradation with one control fungi.

Percentage degradation of detergent was calculated by following formula.

Calculation

$$\text{Percentage detergent degradation} = \frac{\text{Optical density of unknown sample with detergent}}{\text{Optical density of sample (detergent) after inoculation}} \times 100$$

RESULTS

According to identification of fungi isolated from domestic waste waste overall 58 fungal species (1123 colonies) belonging to 18

genera were recorded. Among them 08 fungal species (82 colonies) belong to 15 genera belong to Anamorphic fungi were recorded. belong to 03 genera from *Zygomycotina*, 50 fungal species (1041)

Table 1. Showing the Total number of fungal colonies in Domestic waste water (Detergents rich)

S.N	Name of fungal species	Detergents			Total no of fungal Colonies
		Ezee	Nirma	Fem	
1	<i>Zygomycotina</i>	37	17	28	82
2	Anamorphic	428	243	369	1041
Grand Total number of colonies		465	260	397	1123

Table 2. Showing the detergent biomass in different Detergents.

S.no	Name of the Detergents	Control/ml	1ml	2ml	3ml	4ml
1	Fem	4.0g	3.6g	3.4g	3.2g	2.9g
2	Ezee	4.7g	4.3g	4.2g	4.1g	3.8g
3	Nirma	4.8g	4.6g	4.4g	4.0g	3.8g

Table 3. Showing the detergent Degradation in selected fungi

S.no	Name of Fungi	Name of detergent	OD of unknown sample with detergent at (510 nm)	OD of known sample after inoculation at (510 nm)	Percentage Degradation of detergent %
	<i>Aspergillusfumigatus</i>	Ezee	0.45	0.24	54.66%
	<i>Aspergillusfumigatus</i>	Fem	0.55	0.36	65.45%
	<i>Aspergillusfumigatus</i>	Nirma	0.78	0.45	58.46%

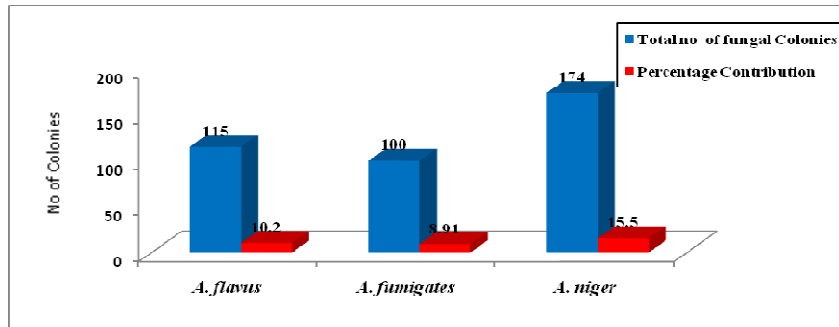


Fig 1. Showing the total no of fungal colonies & percentage contribution in different types of dominant fungi in different types of detergents

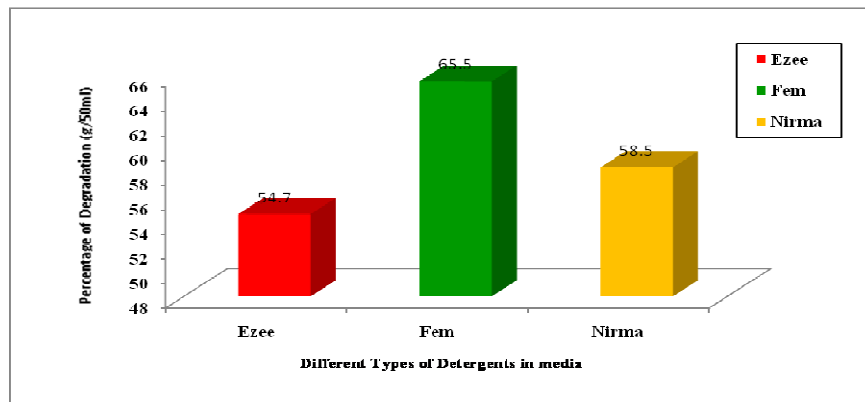


Fig 2. Showing Percentage Degradation of Detergents

DISCUSSION

Our study draws attention towards the pond ecosystem. It is necessary to take important steps to resolve the domestic waste pollution. Pond shall always be present in the planet therefore it has become necessary to find ways and means to remove the pollution from these natural resource with the latest different

techniques and methodology. Which is mostly discharge into them, Because of domestic waste. Hence due to fast growing economical population problem pond is getting increasingly more polluted. Therefore safe drinking water is priority for all living creatures. Environment ministry has already taken many step but still the problem has not totally resolved because of lack of purpose research work to destroy many existing microbes, due to toxicity of

commercial product that are discharge into the pond water.

CONCLUSION

The conclusion of my present investigation states that fungi spore is ubiquitous. The knowledge of microbe's activities in natural conditions is now being suitably employed to ameliorate our degrading environment, including domestic waste treatments and other forms of pollution like recalcitrant Xenobiotic chemicals of anthropogenic origin Mitchell (1974). They are significant pathogens of human and other animal and also cause losses due to disease in society. Besides them fungi found in water are beneficial to industries. Their utilization can be remarkable with the help of different biotechnology tools and their product can also be very useful to human being. The present study draws attention towards population that is exponentially increasing and civilization is depleted due to man-made environment problems, biotechnology should come to the rescue of mankind by providing tools for processing in a proper way where their use are harmful. Once our country can give focus on proper sewage treatment system and sanitation it will be better to recycle the unwanted waste discharged in water. A strategy in attaining this goal is not to restore the disrupted ecological balance, but rather to dynamically transform the industry ecosystem. So that it would combine the technogenic approach with the law of ecosystem evolution.

Our study draws attention towards water pollution caused from domestic waste. The aim of this research is to investigate the effect of increasing detergent concentrations on the total water fungi. The present study includes an environmental hazard assessment of substances in detergents. In this research work, we try to determine how detergents have affected the growth of fungal flora.

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