# Bacterial Endophytes: Nature's Hidden Battalion against Environmental Pollution

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Bacteria are ubiquitous and the first form of life to appear on earth. Bacteria exist in different shapes like spherical, rod and curve. These cells exhibit the potential to live in extreme and hazardous conditions like radioactive waste, volcanoes soon after eruption, in Antarctic ice to boiling hydrothermal environment. Bacteria can be found in symbiosis, in a kind of friendly relationship with the host or may be parasitic, that is, may cause damage to the host. Good bacteria is essential for human body especially in the digestive system to help in breaking down substances that the human body cannot. They are also required for the survival of plants as they serve the function of nutrition supplementation and promote growth. Bacterial endophytes are referred to bacterial cells that reside inside the plant or animal body without causing any disease to the host plant or host animal. Bacterial endophyte forms a part of our environment possessing epiphytic as well as endophytic nature.

Environmental pollution has now reached its peak, contaminating the land, water, air. Recent incidence of toxic froth formation in Varthur Lake, Bellandur Lake are the hideous effects of the polluted water bodies. Various activities like discharge of effluents from industries especially textile and chemical industries, release of domestic waste to flowing water bodies, leaching of heavy metals are major reasons for water pollution. This complex organic compounds access our food chain leading to serious health issue. It was reported by Boivin and Schmidt in the year 2005, that complex organics like 2, 4-D, an herbicide has potential to accumulate in surface water bodies.

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Accumulation later followed by bio-magnification in the human body followed by uncontrolled multiplication of meristamatic cells, inhibiting DNA and Protein synthesis as proposed by Tomlin in the year 1994.Finally leading to various types of carcinoma, damaging endocrine glands andtesticular cells leading to decreased sperm count in testis. Reports also suggest of mother's milk being contaminated with 2, 4-D on exposure. Azo dyes released from textile industries are also known to be carcinogenic, and thus it is essential to study, in detail, the breakdown and the metabolite formed as the result of the breakdown.

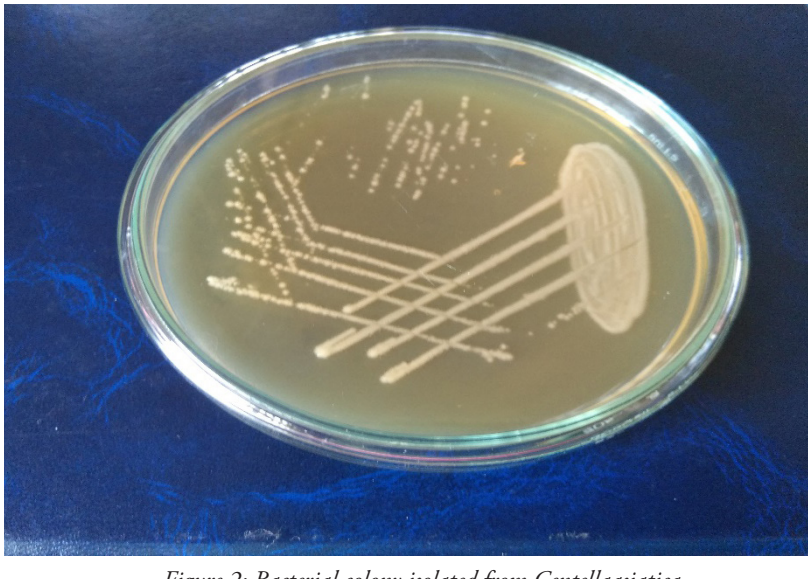

*Figure 2: Bacterial colony isolated from Centellaasiatica.*

Biologically these problems can be treated by employing methods like enzymatic degradation, phytoremediation and microbial bioremediation. Employing plant for the degradation is termed as phytoremediation. This is a cost-effective method of degradation and environmental friendly concept. Phytoremediation has a drawback as plants lack mobility, possibility of remediation is only when the contaminant is in plants vicinity. Enzymatic degradation is an expensive method supplementation of appropriate enzyme would be required for the breakdown of a compound. Concepts of fungal bioremediation is also effective and less expensive provided the only constraint is the delayed multiplication rate of fungal cell thus directly influencing the time required for the degradation. Bacterial bioremediation is quick, cost effective method with high rate of degradation. Usually majority of the studies collect bacteria from contaminated site like for example in case of oil degradation the bacterial cells will be isolated from the site contaminated with oil spill. In case of dye degradation the bacteria will be isolated from the site of textile effluent. The possibility of collecting the pathogenic strains are more in this method. The present study, isolation is carried out from ethno-medicinal plants that are usually consumed by humans and thus the strains isolated are also safe for humans and the environment.

This is a first report of bacterial degradation of a diazo dye, Direct Blue-14 dye by endophytic bacteria. The concepts of employing endophytic bacteria for dye degradation followed by the optimization of dye degradation, prediction of the probable pathway of degradation and the analysis metabolite formed and finally the assessment of the toxicity of the formed metabolite is studied. A complete picture of the bioremediation of Direct Blue-14 dye is explored in the present study.

*Centellaasiatica*, also known as Indian pennywort, is a well-known etho-medicinal plant. Among the four types of bacteria isolated from *Centellaasiatica*, only one strain had the capability to grow and breakdown the dye. Bacteria named *Bacillus fermus* was isolated from the plant and was used in degrading Direct Blue-14 dye. After finding the appropriate bacteria it was essential to know the requirement of the bacteria to degrade the dye. It was found that *B.Fermus,* enjoyed sucrose as source of energy than other source like maltose, lactose and fructose. The possible reason was since it is a plant bacteria it was used to sucrose as it is the most abundant source of carbon in the plant. Better degradation of dye was observed in presence of sucrose. Later, it was essential to understand the amount of dye the bacteria can resist and degrade. It was noted that after the limit of 70 mg/L of dye a drop in degradation was noticed also indicating the reduction of bacterial cells. It was also noted that as the bacterial cells increased the degradation dropped suggesting competition for nutrition. The best degradation was further subjected to understand the break down by bacteria using analytical methods like LC-MS, FT-IR, Spectrometry that revealed the bacteria had broken down the azo bonds that strengthens the structure of the dye was broken thus leading to complete decolourization of the dye. Thus the formed product was subjected to test the toxicity of the metabolite as well as the dye on the genetic material of the cell. Onion cells were used for the purpose of the cytogenotoxicity studies. It was observed that after degradation product or the metabolite was less toxic in comparison to that of dye.


*Figure 3: Comparison between untreated dye sample [A] and treated dye sample [B].*

As it is clearly evident from the above picture that endophytes can completely degrade dye in a day, it is possible to completely treat water from effluent and use it for agricultural purposes. Research is essential in this aspect, as we are aware of water shortage problems that has to be immediately attended. Therefore, I would like to conclude by saying that nature has its defence, all that is required is to research and to understand a method that can reduce the problem that we face today in a simplest way possible. These endophytes are equally good in degrading more complex compounds then dye. Good results were also observed in degrading 2, 4-D pesticide. It is essential to identify the right condition and the right bacteria for a particular compound.