Chapter 19
Advancement in Bioremediation of Pharmaceutical and Personal Care Products

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ABSTRACT

Pharmaceutical and personal care products (PPCPs) are regularly used by human being for their day to day life. These products contains various chemical compounds which are regularly added in our surface and ground water sources either through untreated or partially treated domestic and industrial wastes or through agricultural runoffs etc. These are present at the concentration of µg liter-1, and at such low concentration also these have shown harmful affect to living being. A lot of studies have been carried out for studying their effects on animal biodiversity, which can directly or indirectly affect human being also. So their removal from waste water is essential. Various technologies are being tested for removing these compounds from polluted water; bioremediation is also one of them. Present chapter will briefly give the description of various PPCPs present in waste water, their impact and removal technologies available for their removal with special emphasis on bio remediation.

INTRODUCTION

Water is one of the prime element and necessary for every living being on earth. Two third of the earth is covered by water and major fraction of our body is also made up of water. Further in the body, it regulates the activities of fluids, tissues, cells, lymph, blood and glandular secretions. So its contamination can easily affect our metabolism as well as that of all the living creatures. Fresh water present in the earth's surface is put to multifarious uses. It is used for drinking, domestic and municipal uses, agricultural irrigation, industries, navigation, recreation, etc. The used water becomes contaminated and is called waste water. Water passing through industries, agricultural lands and the urban settlements gets spoiled up and is rendered harmful to plants, animals and human being. This water gets loaded with organic and inorganic chemicals, pathogenic and non- pathogenic organisms including viruses and

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cysts. Usually these waters do not remain fit for human consumption and for life of plants and animals as well. There are different types of pollutants polluting the water e.g. Sewage and fertilizers, chlorinated hydrocarbons and pesticides, heavy metals, oil and petroleum products, radioactive substances, plastics, pharmaceutical and personal care products (PPCPs) etc. Role of PPCPs as environmental pollutant is recent in comparison to other pollutants.

Now the question is what are pharmaceutical and personal care products? Different types of medications both for human as well as for livestock, cosmetic products, and antibiotics for agriculture etc are being used. Excess of these flush out through domestic effluents and become a part of water or sediments/ soil if not treated properly, known as PPCPs. Places where the waste water from hospitals, residential areas and industries are directly released into surface water without pretreatment, chances of presence of PPCPs becomes more prominent. As these group of compounds are still emerging therefore also known as a subgroup of "contaminants of emerging concern," as well as "emerging contaminants" or "trace organic compounds" (Sedlak et. al., 2000). Contaminants of emerging concern as a whole are compounds that are not commonly monitored due to their "emerging" nature. A wide range of PPCPs may be present in wastewater and the environment receiving it (Daughton & Ternes, 1999; Kolpin et. al., 2002). These compounds are mostly less biodegradable, high persistent in the environment, poorly removed in wastewater treatment plants (WWTPs), and often detected in the micro to nano grams per liter concentrations. Leaching of these compounds in groundwater is the potential risk as due to its usage for drinking purposes in most o the areas. The present chapter is providing different aspects of PPCPs such as type of PPCPs present in environment, their impacts on environment and available removal technologies for PPCPs from waste water with the emphasis on bioremediation.

BACKGROUND

Bioremediation was first used by the Romans, at around 600 BC, to clean their waste water. This process was officially invented in the 1960's by George Robinson. He had experimented with microbes inside of polluted glass jars. In the 1970s, Ananda Chakrabarty and his colleagues at General Electric discovered a strain of bacteria that is able to degrade some components in crude oil. He obtained this strain by isolating a Pseudomonas from a soil filled with. First commercial in situ bioremediation system was installed in 1972 to cleanup a Sun Oil pipeline spill in Ambler, Pennsylvania. The Exxon Valdez oil spill in 1989 in Prince William Sound, Alaska, was the genesis of global attention to this process. Importance of bioremediation is that it can completely destroy contaminants, converting them to carbon dioxide, water, and new cell mass. So this can be a good technique for removal of PPCPs from waste water.

Now days many PPCPs are detected at wide concentration ranges in a variety of environmental samples (Halling-Sørensen et al., 1998, Snyder et al., 2003) and in animal tissues, human blood, and breast milk samples (Rimkus et al., 1999; Adolfsson-Erici et al., 2002). Study was conducted by researchers at the U.S. Geological Survey in 1999 and 2000 to provide baseline information on the occurrences of pharmaceuticals, hormones and other wastewater contaminants in water resources. Researchers found organic wastewater contaminants (OWCs) in 80% of the streams e.g. coprostanol (a fecal steroid), cholesterol (a plant and animal steroid), tridosan (an antimicrobial disinfectant), 4-nonylphenol (a non-ionic detergent metabolite) and caffeine as the most frequently detected compounds (Nakada, 2007). The highest concentration reported was 40 ng/l for meprobamate (Benotti et al., 2009). Several pharmaceuticals were found in tap water at different concentrations ranging from nanograms to low micrograms per litre in