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NSAIDS in the Environment: From Emerging Problem to Green Solution

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Abstract

NSAIDs (Non-Steroidal Anti-Inflammatory Drugs), are one of the most frequently recommended pain killer medicines. But NSAIDs in the environment have raised major concerns for their persistence and potential risk for the terrestrial and marine ecosystem. They may cause severe biotransformation or biodegradation of NSAIDs is a necessary requirement for the elimination of these drugs.

Keywords: Biodegradation; Ecosystem; Environment; Non-steroidal anti-inflammatory drugs

Introduction

During these days level of human health care is increasing, so the various pharmaceuticals are frequently used for high life expectations to cure diseases such as muscle pain, headache, and some inflammatory conditions. NSAIDs (Nonsteroidal Anti-Inflammatory Drugs) are generally used to cure any kind of pain. NASIDs are mainly the derivatives of carboxylic acid that act as the inhibition of prostaglandin synthesis made by cyclooxygenase enzyme which is accountable for an indication in tissues from cell to cell [1,2]. Recently over-the-counter drugs are so common, mainly monocyclic or polycyclic nonsteroidal anti-inflammatory drugs (NSAIDs). Among all the human medicines, they are widely used. So, these medicines are preferred for the purchasing without any medical prescriptions due to their low price and fewer side-effects, although it is an inappropriate way to consume any medicine [3]. Monocyclic NSAIDs like- ketoprofen, naproxen, ibuprofen, salicylic acid, acetaminophen are the most frequently utilized drugs [4]. Thus, NSAIDs contains foremost position among extensively used drugs classes which are globally consumed. In the global survey, they represented the 15% of all drugs detection surveys [5] though, comprising various chemical and clinical profiles, they carry the identical therapeutic properties to a large extant and allied with alike harmful effects. According to Harirforoosh et al. [6] this drug causes gastrointestinal, cardiovascular and renal complications in humans.

In last few years, attention has been raised in the direction of presence, sources, discharge and potentially harmful impacts of pharmaceuticals on the environment. NSAIDs also cause the toxicity into the environment even at very low concentration ng L^{-1} to μg L^{-1} as well other pharmaceuticals [7]. Residues of NSAIDs are usually present in surface water, marine water and ground water [5,8]. In spite of this, they have been detected in sewage sludge, wastewater treatment plant and agricultural soils due to application of manure contaminated with pharmaceuticals, irrigation with non-reclaimed or treated wastewater [9-13]. After the disposal drugs to the municipal sewage system they come across to the aquatic environment and then usually reach to the ground water [4]. The presence of pharmaceuticals in natural water systems and their entrance into drinking water facilities affects the water quality and public health [14]. Though excreta of human and animals are the major source of these compounds but some other sources like effluent and spill accidents from manufacturing units, direct disposal of pharmaceuticals by households and medical units, leakage from sewage tanks are equally important factors. Pharmaceuticals are generally detected by Liquid Chromatography-Mass Spectrometry (LC-MS) and Gas Chromatography-Mass spectrometry (GC-MS) in environmental matrices over the past few years [3]. The occurrence of NSAIDs in the environment has become the issue of major concern due to their potential ecotoxicity into the environment as they severely affect the aquatic and terrestrial organisms at different trophic levels [15,16]. Biological activities of NSAIDs may negatively affect the non-targeted biota and consequently harm the ecosystem functioning and allied ecosystem services [17]. Furthermore, constant accumulation and abandoned disposal of pharmaceutical in water streams, municipal waste or landfills may pose the high concentrations and cause the potential risk to living organisms

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[18]. For example, the presence of ketoprofen and diclofenac in wastewater treatment plant usually found up to 1.0 μg L^{-1} and various studies have accounted the toxic effects on fish at same concentrations [19]. Diclofenac contains the utmost level of acute toxicity among all NSAIDs [20]. Renal lesions and alterations of rainbow trout gills were observed at the LOEC of 5μg L^{-1} and minor sub-cellular impacts at 1 μg L^{-1} [21,22]. The population of Indian vulture (*Gyps indicus*) has been decreased due to bioaccumulation of diclofenac into their bodies [23]. Sung et al. [24] reported the acute toxicity of the mixture of ibuprofen and acetaminophen on *N. denticulate*. Various biomarkers ease the early assessment of possible contaminant derived chronic impacts in aquatic organisms using the rapid modification of numerous biochemical responses in a given sentinel organisms [25]. Thus, the degradation of pharmaceuticals has become the need of the present day. The removal of pharmaceutical compounds is primarily done by sewage treatment plants but some refractory compounds are not completely degraded by this process because conventional treatment plants are not mainly designed to remove such drugs [26]. So, various techniques are applied for the treatment of wastewater. Among them, physico-chemical processes are commonly used, such as- advanced oxidation process, photocatalytic degradation, photo fenton process, enhance electrochemical degradation [27,28] though these processes need stringent conditions for the reaction, expensive operational costs etc. [29]. Physico-chemical modifications may cause the formation of more toxic intermediate compounds [30]. Subsequently, bioremediation processes are the attractive alternative to these processes. This approach is cost effective and facilitates the mineralization of NSAIDs into harmless products. Various studies have illustrated that the action of microorganisms, plants, and animals within specific conditions that deal with both abiotic and biotic factors to attain contaminant mineralization, sorption, transformation or immobilization [31,32]. Some bacterial species, such as *Planococcus* sp. *S. maltophilia* , *B. thuringiensis, E. hormaechei*, *Pseudomonas* sp., *Patulibectar* sp., *Sphignomonas* have shown their degradation potential towards NSAIDs [29,33-38]. Several species of fungi have also shown significant of degradation of NSAIDs, for instance, *T. hirsute*, *S. dehoogii*, *T. versicolor*, *P. chrysosporium, B. Adusta*, *C. elegans* [39-43]. Thus all of above studies have illustrated the importance of microbial degradation of NSAIDs. Generally, native species are used for the degrading pollutants. Indigenous species are more capable of removing contaminants. So, this technique is the sustainable way to clean the terrestrial and aquatic ecosystem.

Conclusion

Eradication of NSAIDs waste in the environment demands the future research and studies to promote the dynamic biodegradation process which is based on sustainable development. Pharmaceutical waste as the emerging contaminants cause the serious challenges to soil, air, and water. Apparently, productions of new drugs are increasing and some of them are not detected by current safety monitoring systems and existing remediation technologies are not sufficient. So, there should be interdependence among the environmental effect on fate and bioavailability of pharmaceutical contaminants and the selection and performance of most relevant biodegradation techniques with identical techniques that facilitate the efficient functioning and monitoring of a biodegradation process. Therefore, various factors like type of drug, its concentration, phase, and extent of the drug, application of biodegradation techniques on lab scale or field etc. are interrelated. Furthermore, the elimination of waste generated from pharmaceuticals from the environment would be inevitable by employing multidisciplinary techniques.

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