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ENVIRONMENTAL AND HEALTH HAZARDS DUE TO PHARMACEUTICAL EFFLUENTS

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ABSTRACT

Environment and health are directly or indirectly affected by pharmaceutical effluents especially in the vicinity of pharma industrial zones. Though untreated or partially treated effluents released by pharma industries, drinking water sources are being polluted. Different classes of pharmaceutical compounds like analgesic, antidepressant, antihypertensive, contraceptive, antibiotic, steroids and hormones etc. have been detected in water samples from ng/L to µg/L range. Though the detected amounts are very minute but highly toxic for human, animal and aquatic lives. There is a need of regular monitoring of concentration of pharmaceutical compounds in pharmaceutical effluents entering into drinking water sources in order to save environment as well as living form of lives from health hazards. The present paper highlights such toxicity, health risk and assessment of environmental hazards due to pharmaceutical pollutants.

Key words: Pharmaceutical effluent, Drinking water sources, Health Hazards.

INTRODUCTION

Pharmaceutical compounds are being used for several beneficial purposes in modern society but simultaneously pharma industries are releasing very toxic contaminants in the environment directly or after chemical modifications [1]. Moreover, pharmaceutical compounds may enter the environment by different routes such as discharge of treated wastewater, seepage from landfills sites, sewer lines, runoff from animal wastes etc. [2,3] Even though various physical and biological processes occurring in aquatic ecosystem may cause reduction of many pharmaceutical compounds, trace concentrations of human and veterinary pharmaceutical compounds as well as their metabolites have been detected in different water bodies like surface water, groundwater and drinking water sources [4-6].

The pharmaceutical industry in India is the world's third-largest in terms of volume and stands 14th rank in terms of value. It is growing at about 8 to 9 percent annually and is estimated to be worth 4.5 billion dollar**.** Different industries including pharmaceuticals, chemicals, paints etc. are speedily growing in India which dispose off their effluents into the streams either directly or after partial treatment [7]**.** It has been found that the pharmaceutical compounds reach the environment and can be considered as environmental pollutants. Several pharmaceutical production facilities were found to be sources of much higher environmental concentrations than those caused by the applications of drugs [8]. Generally, pharmaceutical industries generate a huge quantity of wastes during manufacturing and maintenance operations. Pharmaceuticals have been detected in wastewater treatment plant effluents and drinking water sources. Trace amount of pharmaceuticals in drinking water for longer duration may cause considerable adverse effects to human health and aquatic life, though concentrations of pharmaceuticals detected in drinking water (in nanogram per litre range) are several orders of lower magnitude than the minimum therapeutic dose [9]**.** There is currently no Bureau of Indian Standards (BIS)/ regulations limiting the levels of pharmaceuticals in wastewater or drinking water. However, the United States Environmental Protection Agency [10] has added four pharmaceutical compounds,

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which extensively used by human, to the most recent contaminant candidate list (CCL 3) including three birth control substances and one antibiotic. The present paper highlights and reviews the impact of pharmaceutical effluents on nearby drinking water sources.

Classes of Environmental Pollutants i.e. Pharmaceutical Compounds

Pharmaceutical drugs being used for human as well as veterinary medicines are emerging as environmental pollutants. Different pharmaceuticals have been classified as given under Table 1 [11]**.**

Pharmaceuticals in the Environment:

The environmental exposure routes of pharmaceuticals into the environment are manufacturing units and hospital effluents, land applications (e.g., bio solids and water reuse) etc. [12] However, sewage treatment services are not always successful in removing the active chemicals from waste-water. Consequently, pharmaceuticals find their way into the aquatic environment, where they directly affect aquatic organisms and can be incorporated into food chains. In a recent study, the extraordinarily high levels (mg/L) of several drugs were found in the effluents from local wastewater treatment plant near Hyderabad in India [11].

Toxicity due to Some Pharmaceutical Compounds

Studies on antibiotics have shown that up to 95% of antibiotic compounds can be released unaltered into the sewage system. Moreover, higher concentrations of antibiotics can lead to change in microbial community structure and ultimately affect food chains. Non-steroidal anti-inflammatory drugs (NSAIDs), like ibuprofen, naproxen and diclofenac are widely being used and consequently are frequently detected in sewage, surface water and may be found in ground water system. Ibuprofen, ketoprofen, naproxen, indomethacin, diclofenac, acetylsalicyclic acid and phenazone have been found in surface water system. However, diclofenac, ibuprofen and propyphenazone are the most commonly found drugs in the water bodies after clofibric acid. Moreover, diclofenac has been proven to be highly toxic for vultures and cattle's [13]**.** NSAIDs like ibuprofen, naproxen and aspirin are the most commonly used drugs, which are usually found in effective quantities in municipal effluents [14,15].

Properties of Pharmaceutical Effluents

Many pharmaceutical industries are responsible to generate toxic effluent as a consequence of their operation. The waste water generated from these industries possess solids, biodegradable and non degradable organic compounds etc. Pharmaceutical effluents offer basic information about the reliability of the aquatic habitat in rivers and streams, into which they are discharged. The physico-chemical analysis of the effluents should indicate that most of these industries obey the standard guidelines of Federal Environmental Protection Agency (FEPA) [10]. An important pollution index of industrial wastewaters is the oxygen content in chemical oxygen demand (COD) and biological oxygen demand (BOD), where the nutrients status are measured in terms of amount of nitrogen and phosphorus in waste water. Besides this, other significant water quality parameters include pH, temperature and total suspended solids (TSS) [16]. However, pharmaceutical effluents are also categorized by their unusual turbidity, conductivity, COD, TSS and total hardness.

Pharmaceuticals Analysis in Drinking Water

The mystery of pharmaceutical occurrence in drinking water has particularly concerned the public health. While unpleasant human health results from the existing levels of drugs and pharmaceuticals in drinking water are highly unlikely, the resulting impacts to aquatic ecosystems are more dangerous. Moreover, pharmaceuticals have been detected in waters for more than four decades. In the past decade, the number of papers on the analysis of drugs or pharmaceuticals in drinking water sources has increased considerably [2-5].

In a monitoring study, out of fourteen pharmaceutical drugs analyzed, some pharmaceuticals like acetaminophen (detection frequency 0.32%), codeine (0.16%), p-xanthine (0.08%), sulfamethoxazole (0.41%), caffeine (0.24%), carbamazepine (1.5%) and trimethoprim (0.08%) have been detected at concentrations more than or equal to detection limits of selected methods. Besides, detection frequencies of pesticides (33%) and trihalomethanes (28%) in the same sources were reported considerably higher [17].

The pharmaceuticals have been identified in water cycle at trace levels by advanced analytical techniques and instrumentation. Several reports have confirmed the presence of pharmaceuticals in effluents of pharma industries and in municipal wastewaters and these have been recognised as a major source of drugs and pharmaceuticals in drinking water. Most of the research work has been performed on the analysis and detection of pharmaceutical in drinking water samples in developed countries including USA, Japan, the Republic of Korea and some countries in Europe [9]**.**

Health Risk of Pharmaceutical Effluents

The long term exposure of lower concentration of complex pharmaceutical mixtures on stream biota may result in acute and chronic damages [18,19]**,** behavioral changes [20,21], accumulation in tissues [22], reproductive damage [23] and inhibition of cell proliferation [24]**.**

Several studies have demonstrated that fish exposed to wastewater effluents can exhibit reproductive abnormalities. Moreover, fish exposed to trace levels of birth control pharmaceuticals in the range of concentrations found in the environment show dramatic decreases in reproductive success, suggesting population level impacts are possible [25]**.**

Assessment of Environmental Hazard

Globally, the detection of waste pharmaceuticals in the environment creates the risks, which are associated with their introduction into human, aquatic life and

Table 1. Important classes of pharmaceuticals

Sr. No.	Class of Pharmaceuticals
1.	Analgesics
2.	Antibiotics
3.	Antiepileptic
4.	Antiseptics
5.	Beta-blockers
6.	Antihypertensive
7.	Hormones
8.	Contraceptives
9.	Psychotherapeutics

wildlife and is becoming a serious problem equally for both regulators and the pharma industry. Significant success on this issue is simply not achievable with the currently limited state of knowledge on environmental transport, fate, and effects of pharmaceuticals. There is need to take into consideration the possible growing effects of different drugs affecting the same receptors [12], Risk assessment of the pharma chemicals involves the detection of the inherent hazards at each stage and an estimation of the risks due to these hazards.

CONCLUSION

Currently, pharmaceutical compounds are being merged into the environment in extremely large quantities regularly and present system of regulations of their release is not able to control the untreated or partially treated pharma effluents. The impacts of drugs are entering into and occurring on ecosystems, biota and humans. The side effects on human, aquatic and animal health need to be investigated through thorough safety and toxicological studies. Sincere efforts are required to reduce the problem along with some adequate regulations to monitor or to control them. Water quality guidelines enforced in India needs to include analysis of most commonly used pharmaceutical compounds in drinking water sources. Moreover, the latest remedial measures need to be adopted at large in effluent treatment plants of pharmaceutical industrial units to check long term environmental and health hazards.

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