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Editorial Article

Pharmaceutical Pollution: Perception and Management

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Introduction

Pharmaceutical pollution is of great concern and has been the focus of an increasing number of recent studies. Although the use of pharmaceuticals has positive effects on treating many diseases in animals and humans, their improper use has become a new environmental problem. More than 600 pharmaceutically active compounds have been detected in various environmental waterways and even in drinking water [1]. The most commonly pharmaceuticals detected in environmental samples are antibiotics, hormones, non-steroidal anti-inflammatory drugs, and antidepressants [1]. Pharmaceuticals have been detected in wastewater, surface water and ground water at trace levels ranging from µg/L to ng/L [2]. Continual release of medications into the environment at these low concentrations poses adverse effects on human and wildlife [1]. It is worthy to mention that occurrence of antibiotics in the environment may develop bacterial resistance [3] and accumulation of non-steroidal anti-inflammatory drugs such as diclofenac has shown to cause harmful renal effects [4]. It is documented that thinly estradiol at trace levels may cause feminization of fish [1].

The main source of discharging pharmaceuticals into the environment is the disposal of expired /unused medications via domestic water streams [5]. Because of the polarity and stability of pharmaceuticals, most of them are not completely removed in wastewater treatment plants [5]. Many studies have been developed to assess the levels of pharmaceutical residues in different environmental samples; most of them are conducted in developed countries. However, there is a dearth of such information in the Middle East. Almost all Middle East countries have no standard protocols or regulatory policies for disposing pharmaceuticals. In addition, many drugs are sold in the Middle East without a need for a prescription which increased risk of accumulation of unused medication. Furthermore, most of waste water treatment plants in the Middle East are conventional and not specifically designed to remove pharmaceuticals. For a more comprehensive picture of the global situation, further studies should be undertaken in Middle East countries, especially for those which have large human population. It is also highly required to provide baseline information of the level of pharmaceutical waste on such countries. This information will provide insights for regulators and decision makers when designing future interventions regarding disposal of pharmaceutical waste into the environment. Monitoring of the pharmaceutical residues in environmental samples is of a paramount importance. Accurate and sensitive analytical methodologies have been developed to determine pharmaceuticals in waterways. The most widely used analytical techniques are LC Coupled to Mass Spectrometry (LC-MS & and LC-MS-MS) or Gas Chromatography Coupled to Mass Spectrometry (GC-MS). As most pharmaceuticals are polar, LC is considered the technique of choice in most commercial and research laboratories [6-10]. Analytical methods based on mass spectrometric detection are favoured because of its high sensitivity and selectivity. Recently, the development of faster and more sensitive methods became more feasible using UHPLC. This technique can potentially provide greater resolution, increased sensitivity, and speed of analysis. LC coupled to tandem mass spectrometry (LC-MS-MS) is the most common approach used for the analysis of CECs in complex matrices such as wastewater.

Nevertheless this approach is highly selective, sensitive and precise, it still has some limitations. LC-MS-MS can be used only for targeted analysis. However for screening methods full scan acquisition is required which permits retrospective analysis and detection of "non-target" analyte. This explains the tendency to use high resolution mass analyzers such as time-of-flight (LC-TOFMS) or orbitrap (LC-Orbitrap MS), which have the ability to operate in full-scan mode [11]. Thus these approaches are suitable for the development of screening methods based on using accurate-mass databases.

With the awareness about the environment, the development of green technologies has been receiving increasing attention with the aim of minimizing the negative impacts caused by the ana-

lytical processes. Several strategies have been proposed to achieve this goal such as using more benign solvents, increasing the analysis speed s and miniaturization of analytical devices [12]. Establishment of disposal programs aiming at regulating the improper disposal of pharmaceutical waste is an effective regulatory measure helps to minimize the amount of pharmaceutical waste entering the environmental water ways. Also, raising public awareness about the environmental risks associated with improper disposal of pharmaceutical waste and educating them on the proper ways of disposing unused medications can also minimize the environmental contamination caused by pharmaceutical waste. In addition, wastewater treatment plants should be improved by adding up new techniques for treatment such as reverse osmosis, micro filtration or membrane reactor, UV- water treatment, ozonation, treatment with powdered active carbon phase and solar treatment of effluents. Also, further research is needed to investigate the chronic toxicity of pharmaceuticals in the aquatic environment.

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