Chapter 13
Advances and Evolution of Techniques for Pesticide Estimation

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ABSTRACT

Pesticides that are meant for the demolition of pests have become a nuisance for public health and environmental safety. Hence, the detection of pesticides in various types of samples such as food, environment, and even bodily fluids from various living entities is essential. Even though spectroscopic techniques are widely used for routine detection and quantification of pesticides, these techniques cannot determine pesticides with accuracy assured by chromatographic techniques. This chapter deals with various pesticide analysis techniques and the limitations associated with each technique.

INTRODUCTION

Pesticides are chemical compounds used for the demolition of various types of pests in agriculture. Pesticides can be classified according to the type of pests targeted as herbicides or weedicides (unwanted vegetation), insecticides (insects), rodenticides (rodents like rat), bactericides (bacteria), larvicides (insect larvae) and fungicides (fungus). As agricultural practices had seen major developments in last few decades owning to the increased requirement of food, the production and usage of pesticides got increased. Between 1960 and 2000, the global production of cereal grains had increased from 0.8 to

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$2.0x10^9$ megatonnes. Similarly, pesticide production in global scale also got increased from 0.4 to $3.0x10^3$ tonnes within the same time period (Tilman et al., 2002). This exponential raise in pesticide production demonstrated the use of pesticides in almost all agricultural lands to improve productivity and vice versa. Increasing resistance of pests towards pesticides demands for higher application quantity per unit area and thereby requirement of more pesticides for agricultural fields. Alternatively, new potent pesticides that can eliminate pests at much lower doses are developed (Carvalho, 2006). Currently, natural and environmentally safe organic farming methods are gaining momentum although the expenses associated with it is high. As organic farming methods show far less productivity compared to conventional farming, it is less likely that organic farming can overhaul conventional farming practices. Hence, the production of pesticides is also less likely to get reduced drastically over the course of time.

Studies have found compelling evidences that prove detrimental effects of pesticides on human health and environment. In France, pesticide contamination of river streams have shown to expunged certain sensitive species and caused a 2.5 fold decrease in leaf-litter breakdown rate (Schäfer et al., 2006). Chlorothalonil, an organochlorine pesticide is correlated positively with an increase in mortality rate of various aquatic organisms such as amphibians, zooplanktons and algae. As a direct result of pesticide contamination, deregulations in various aquatic ecosystems such as decreased rate of organic decomposition, reduction in water clarity and increased dissolved oxygen were observed (McMahon et al. 2012). Apart from environmental toxicity, pesticide residues present in various consumer products affects general public health at large. Even though pesticides are designed specific for pests in agricultural fields, many off-target organisms that are exposed to pesticides undergo significant health related changes. Numerous reports have claimed various health-related issues associated with the mere exposure of toxic pesticides. One of the common biological effects associated with pesticide exposure is the inhibition of enzyme acetylcholine esterase (AChE) (Fulton & Key, 2001). This enzyme is responsible for the rapid clearance of acetyl choline, a neurotransmitter, from synaptic cleft. When inhibited, the absence of AChE leads to the accumulation of acetyl choline and thereby affecting the normal functioning of central nervous system. Apart from this, studies have correlated the pesticide exposure with a myriad of disorders including neurodegenerative conditions such as Parkinson's (Baltazar et al., 2014) and Alzheimer's disease (Singh et al., 2014), Dermatological conditions such as dermatitis (Sanborn et al., 2007), Reproductive dysfunctions (Sharpe & Irvine, 2004) such as fetal abortion and infertility and various types of cancers (Abdi et al., 2017).

Increasing pesticide contamination of various natural sources is considered one of the common factors for public exposure to pesticides. Natural sources such as rivers, lakes and ground water are easily contaminated by pesticides present in agricultural runoff water. Processing of pesticide contaminated water is absolutely necessary before releasing it to the natural sources or to direct public consumption. Many municipal wastewater treatment plants are inefficient in processing pesticide containing wastewater. Studies have found the trace levels of pesticides in both influent and effluent from wastewater treatment plants (Sadaria et al., 2017). Hence, unique processing and treatment methods specific to pesticides should be used prior to the release of water from treatment plants. Ground water contamination with pesticides is one of widely reported events that can result in direct public exposure to pesticides. In India, ground water contamination with organophosphorous and organochlorine pesticides has resulted in the presence of pesticide residues in packaged drinking water. Ground water is widely used for the manufacturing of packaged waters only after proper purification. As ground water contamination was evident and presence of pesticides in drinking water was confirmed, industries that process drinking water were asked to increase the stringency of their purification methods. Government of India has established the mandate