Analytical artifacts, sample handling and preservation methods of environmental samples of synthetic pyrethroids

Saeed S. Albaseer, R. Nageswara Rao, Y.V. Swamy, K. Mukkanti

Sample handling and preservation methods of environmental samples of synthetic pyrethroids (SPs) are very important and must be controlled to maintain sample integrity during analytical determinations. However, published literature has treated this issue only partly, and, in many instances, with contradictory conclusions.

The tendency of SPs to adsorb – to varying degrees under different conditions – to surfaces and solid particulates with which they come in contact may be responsible for this situation. It has become evident that SPs discharged to water bodies are present mainly in the adsorbed state, and that affects their bioavailability and the reliability of analytical results. Refrigeration and storage in the dark are prerequisites for stabilization of SPs in environmental samples.

Several other factors that contribute to SPs instability include:

(1) matrix composition;

(2) container material; and,

(3) sample acidity.

Sample agitation prior to analysis may be useful to reduce losses due to adsorption. There are several chemical reagents that inhibit the degradative processes of SPs, but the efficiency of preservation depends – to a large extent – on the characteristics of sample matrix.

This article reviews various aspects related to preservation of SPs and puts forward a preliminary guideline for proper practice during sampling, storage and sample preparation of SPs.

Keywords: Adsorption; Analytical artifact; Environmental analysis; Preservation; Sample handling; Soil analysis; Stability; Suspended particle; Synthetic pyrethroid; Water analysis

Saeed S. Albaseer, K. Mukkanti
Centre for Chemical Sciences and Technology,
Institute of Science and Technology, JNT University,
Kukatpally, Hyderabad 500085,
India

R. Nageswara Rao*
HPLC group, Analytical Chemistry Division,
Indian Institute of Chemical Technology, Tarnaka,
Hyderabad 500007,
India

Y.V. Swamy
Bioengineering and Environmental Centre,
Indian Institute of Chemical Technology,
Tarnaka, Hyderabad 500007,
India

*Corresponding author.
Tel.: +91 40 2719 3193;
Fax: +91 40 2716 0387;
E-mail: rnrao55@yahoo.com,
rnrao@iict.res.in

1. Introduction

Synthetic pyrethroids (SPs) are a class of pesticides widely used for agricultural and household purposes. SPs are synthetic esters derived from the naturally-occurring pyrethrins. Commercially-available SPs include allethrin, bifenthrin, bioresmethrin, cyfluthrin, cyhalothrin, cypermethrin, deltamethrin, esfenvalerate (fenvalerate), flucythrinate, flumethrin, fluvalinate, fenpropathrin, permethrin, phenothrin, resmethrin, tefluthrin, tetramethrin, and tralomethrin (Fig. 1). Their use has increased in recent years because they are:

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(1) selective in action, which is mainly due to differences in uptake and distribution [1]; and,
(2) easily degradable in the environment when compared to other classes of pesticides [2].

However, some of the most recently developed generations of SPs can persist in the environment for a few months before they are degraded [3]. Use of these toxic compounds is expected to increase because they are increasingly used in place of other classes of insecticides (e.g., organophosphates) [4]. But, the increase in SPs use has subsequently raised concerns about their effects on the fate of aquatic life, as SPs are highly toxic to aquatic invertebrates [5], although toxic effects on human health are still unclear. Also, data on long-term effects and chronic toxicity on the environmental species is very limited.

The EU Directive on Drinking Water Quality (98/83/CE) established 0.10 μg/L as maximum contaminant level (MCL) for individual SPs and 0.50 μg/L for total SP pesticides [6]. For various reasons, analysis of most of the environmental trace contaminants cannot be done on site, so it is essential to collect a representative sample (sampling) and to preserve it until analysis. Several factors have been reported to affect the stability of SPs during sampling and storage. It is, therefore, important to consider the influence of these factors on SP stability to get representative analytical samples of the real situation, and, subsequently, accurate assessment of their impact on the environment.

A recent review [7] showed that there is a plethora of analytical methods for analysis of SPs in environmental matrices, but the ability to preserve the collected samples until they can be analyzed in the laboratory is a challenging task. Published studies on the stability of SPs in environmental samples are, in many instances, contradictory. In this article, we review these studies, and attempt to identify the sources of contradiction. Besides, on the basis of published literature and our experience, we make suggestions concerning the optimum conditions for maintaining the environmental samples of SPs during handling and storage.

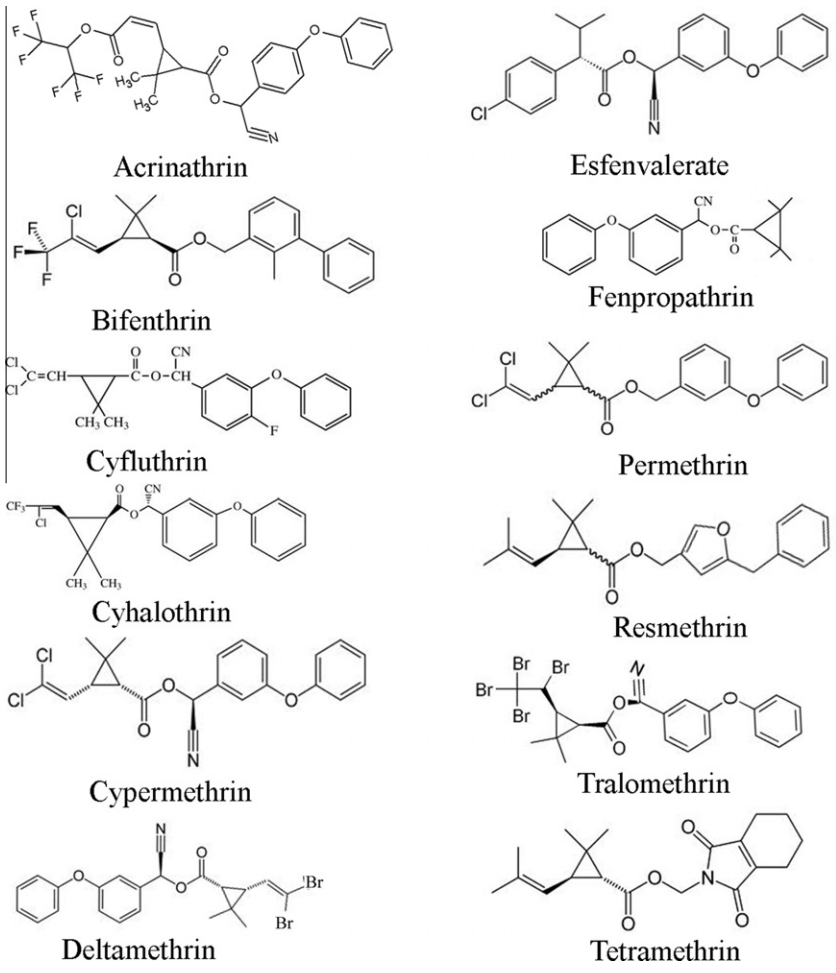

Figure 1. Chemical structures of selected synthetic pyrethroids.