

Persistent organochlorine pesticide residues in freshwater systems and sediments from the Eastern Cape, South Africa

RO Awofolu¹ and OS Fatoki^{2*}

¹Department of Chemistry, University of Fort Hare, Alice 5700, South Africa

²Research & Development Office, University of Venda for Science & Technology, P/Bag x5050, Thohoyandou 0950, South Africa

Abstract

Persistent organochlorines such as Σ DDT, chlordane, hexachlorobenzene (HCB), heptachlor and endosulfan were determined in water and sediment samples of freshwater systems in the Eastern Cape Province of South Africa that receive runoff from agricultural lands and effluents from industries. The organochlorine pesticides (OCPs) in water and sediments were determined by liquid/liquid extraction and Soxhlet extraction methods, respectively. Percentage recoveries ranged from $71.03 \pm 8.15\%$ (dieldrin) to $101.25 \pm 2.17\%$ (α -BHC) in water and from $88.22 \pm 7.85\%$ (endrin) to $109.63 \pm 5.10\%$ (β -BHC) in sediment. The OCP levels ranged from trace (2,4'-DDD) to 450 ± 0.0002 ng/l (β -BHC) in water samples and from trace (aldrin and 2,4'-DDD) to $184 \times 10^3 \pm 0.7$ ng/kg (β -BHC) in sediments for triplicate analyses. Some endocrine-disrupting OCPs such as 2,4'-DDT, 4,4'-DDT, 2,4'-DDE, heptachlor, endosulfan and the chlordanes were detected.

Keywords: organochlorine pesticides, water, sediments, GC-ECD

Introduction

The presence of organochlorine pesticides (OCPs) in the environment has been of great concern due to their persistent nature and chronic adverse effect on wildlife and humans. Despite the ban and restriction on the usage of OCPs in developed countries during the 1970s and 1980s, some developed countries are still using them for agricultural and public purposes because of their effectiveness in controlling various insects (Tanabe et al., 1994). The early spectacular success of dichlorodiphenyl-trichloroethane (DDT) for malaria control in some countries has seen the continuous use of this insecticide in developing countries. Studies have suggested that these compounds may affect the normal function of the endocrine system (Hileman, 1994). The ability of the prevalent isomer of the major and most persistent DDT derivative, 2,4'-dichlorodiphenyldichloro-ethylene (2,4'-DDE), to bind to the androgen receptor in male rats has been reported (Keice et al., 1995). OCPs have also been linked to human breast and liver cancers and to testicular tumors and lower sperm counts in humans (Davies and Barlow, 1995; Cocco et al., 1997).

The appearance of DDT and its metabolites in human tissues and its effect on wildlife (USEPA, 1975) triggered its determination in food (Doong and Lee, 1999), water (London et al., 2000) and human milk (Okonkwo et al., 1999). OCP residues have also been found in sediment (Naude et al., 1998) and wildlife (Heath and Claessen, 1999) at significant concentrations.

Water monitoring for OCPs in South Africa (Weaver, 1993; Grobler, 1994; Naude et al., 1998; London et al., 2000), developed European (Fernandez-Alba et al., 1998), Asian (Iwata et al., 1994) and American (Dorothea and Muir, 1991) countries, has shown a widespread occurrence of residues of these pesticides in environmental water systems, though they have been banned for decades. In

developing countries such as South Africa, this group of chemicals is still used in agriculture, and it is believed to still be in use clandestinely under unknown trade names, due to their low cost. DDT is still used officially in malaria areas for malaria vector control applied by the Department of Health and Welfare. However, there is still a paucity of data on OCP residues in the South African water environment.

Liquid/liquid extraction (LLE) is a common method used for the determination of organic pollutants in water (USEPA, 1984; Tan, 1992; Hernandez et al., 1993; Powell, 1995). The study by Tan (1992) has shown this method as more reliable than solid phase extraction. The use of commercial solid phase extraction cartridges during sample preparation has been shown to render interferences, especially when gas chromatography-electron capture detection is used for analysis. Extraneous peaks, which appear in the gas chromatograms, have been attributed to phthalate esters contained in the housing materials of these cartridges. The liquid/liquid extraction method was evaluated in this study using 15 OCPs in water from freshwater sources using dichloromethane (DCM) as solvent. This study indicated that the liquid/liquid extraction method for sample enrichment of OCPs in the environmental water samples would render to more reliable data.

Soxhlet extraction (SE) is an established technique that has been used for the extraction of organic pollutants from marine sediment and soil samples (USEPA, 1990; Snyder et al., 1992). In this study, a Soxhlet extraction method for the determination of 15 OCPs in sediment was evaluated.

The methods – liquid/liquid extraction and Soxhlet extraction were applied to monitor for OCP residues in freshwater systems. The study areas selected were the Buffalo, Keiskammahoek, Tyume and Swartkops Rivers as well as the Sandile Dam, in the Eastern Cape Province of South Africa.

The objectives of this work were to use the liquid/liquid extraction and Soxhlet extraction methods that would be evaluated to determine the levels of OCPs in freshwater and sediment from the Eastern Cape and to assess whether the levels detected in water and sediment pose cause for concern.

* To whom all correspondence should be addressed.

+2715 962 8504; fax: +2715 962 8493; e-mail: Fatoki@univen.ac.za
Received 29 July 2002; accepted in revised form 3 March 2003.