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Review Article

Application of The Principles of Green Chemistry in Residues Analysis of Pesticide Chemicals in Water: 20years Experiences in Egypt

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Summary

Residues analysis of pesticide chemicals in water is necessary for solving various environmental problems, as natural water are usually contaminated with a large number of these chemicals [1]. Analysis of these chemicals in water usually is carried out using GC, HPLC, GC-MS and HPLC-MS and required ppb levels [1-3]. Analysis with such low levels is complicating problems which can be solved by using a concentration step (trace enrichment for residues of pesticide chemicals) prior to the chromatographic analysis. Before 1989, liquid-liquid extraction (LLE) as a tool for trace enrichment was frequently used in our laboratories for analysis of pesticide residues in water samples. In LLE there are some problems such as: a large sample volume may have be processed to yield analyses concentration to be sufficient for chromatographic detection, it requires large amounts from extraction solvents (generate a waste from toxic solvents), it is laborious, slow, difficult to automate (energy consuming) and it gives different extraction efficiencies for various compounds, finally LLE is environmentally friendless. Because of the increasing demand for eco-friendly methods for trace enrichment of pesticides residues from water samples is a major incentive to improve the classical procedures which have been mentioned previously and is an important step on the way of using "greener" analytical methods for analysis of pesticides residues in water. Considering the previously mentioned problems we present here a short review about some eco-friendly procedures that have been

developed, validated and elaborated in our laboratories science 1989 for trace enrichment of pesticide residues from water samples. These procedures such as micro liquid liquid extraction (mLLE) and solid phase extraction (SPE, using different sorbent materials and different formats, such as: porous polymer Amberlite XAD2 (bulk form packed in glass column, Figure 1. [4,5], C18bonded silica cartridges , graphitized carbon black cartridges(GBC) and C 18 Empore membrane disk, Figure 2 and Figure 3).

Figure 1: Schematic diagram showing SPE using porous polymer Amberlite XAD2 (bulk form packed in glass column) for extractions of pesticides residues from water samples under investigations.

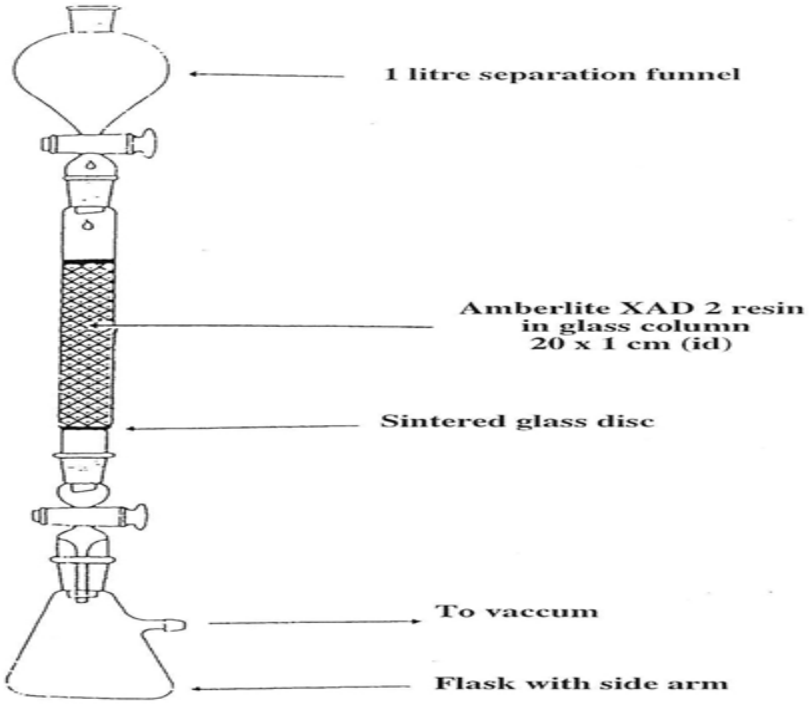


Figure 2: Schematic diagram showing steps involved in SPE using Empore disk C-18 for trace enrichment of pesticides residues in water samples under investigations.

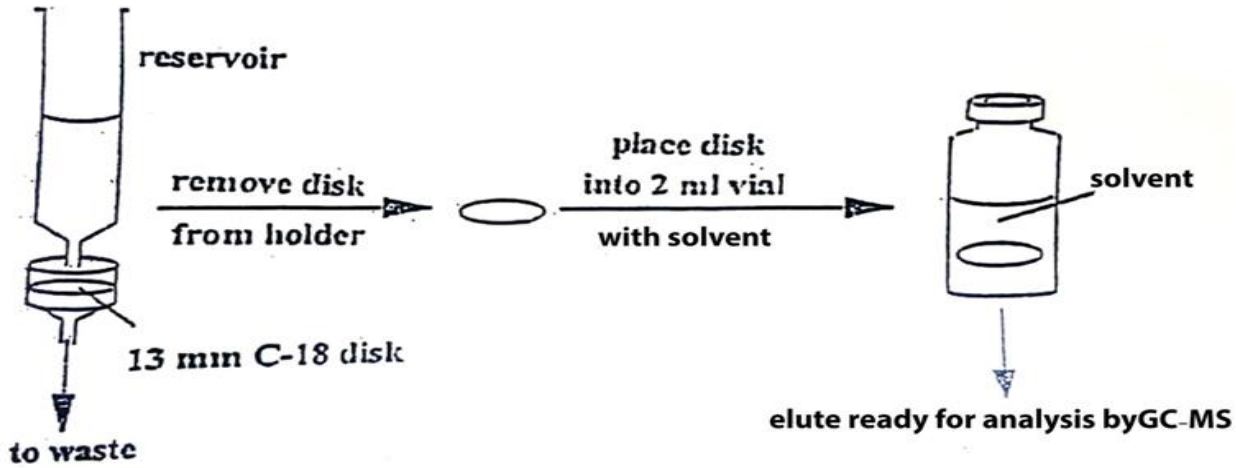
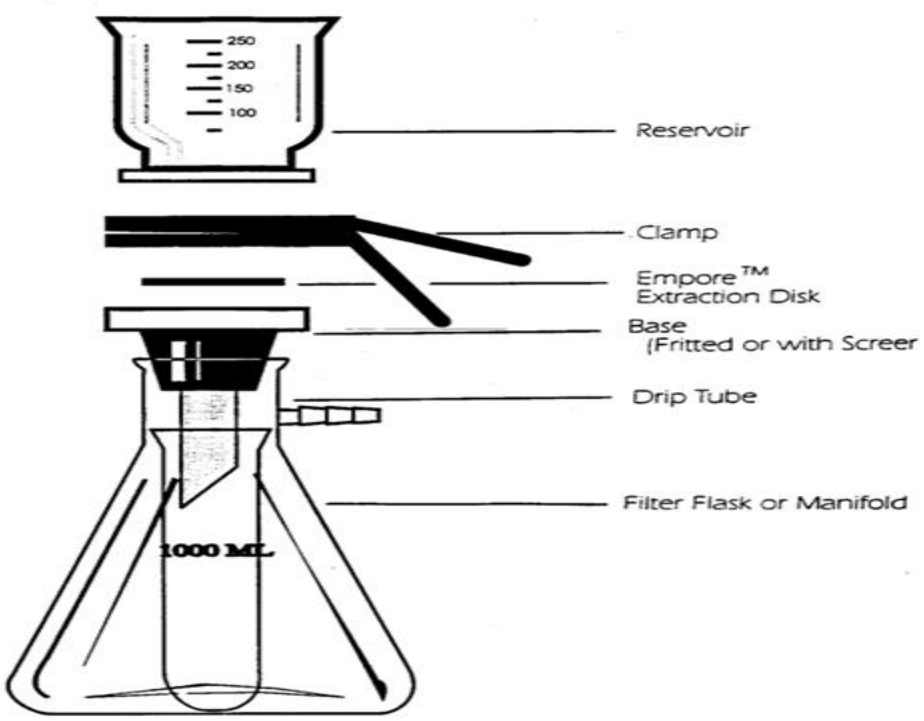


Figure 3: Schematic diagram showing apparatus for Empore Disk- C 18 SPE technique for trace enrichment of pesticide residues in water samples under investigations.



An analytical method for analysis of 15 chlorophenoxy acetic acids herbicides residues in water based on amber lite XAD2 as SPE sorbent for trace enrichment was developed and validated by [4,5]. Residue analysis for 13organochlrine insecticides (OC) in surface water of Tanta area (Figure 4), was done using Amber lite XAD2 as SPE sorbent for trace enrichment [6]. Residues analysis for 10 OC and 2 organophosphates (OPs) in surface waters in some agricultural irrigation canal and some adjacent irrigation drains in Kafr El- Sheikh area, Figure 4B, were done using C18 cartridge as SPE sorbent for trace enrichment by [7,8].

Graphitized carbon black cartridges (GPC) were used as efficient SPE sorbent for trace enrichment 0f 10 OPs (polar compounds) in surface waters [9]. C 18 Empore membrane disk, Figure 2, were used by [10] for analysis of 10 OCs in surface and tap waters.

C18 bonded silica cartridges, C 18 Empore membrane disc-C18 bonded silica, Figure 3 and Micro liquid extraction (mLLE), Figure 5 were used by [11-13] for analysis of 18 OCs and 10 OPs in surface and drainage waters of agricultural intensive area at Damanhur, El-Behira Governorate (Figure 4C) Egypt. For mLLE, a handmade extraction apparatus as shown in Figure 5 was constructed according to [14]. For water samples extraction a 500 mL of samples were transferred into a 500-mL separating funnel and then 0.5 mL of n-hexane was added, the mixture was mechanically shaken for 2 min.

The supernatant organic phase was raised up to the bottleneck of the separating funnel (Figure 5) by raising a communicating vessel filled with deionized water. Raising of the level ensures the collection of the liquid with a Pasteur micropipette, the extract being thus ready for analysis.

Figure 4: Areas map for sampling of water.

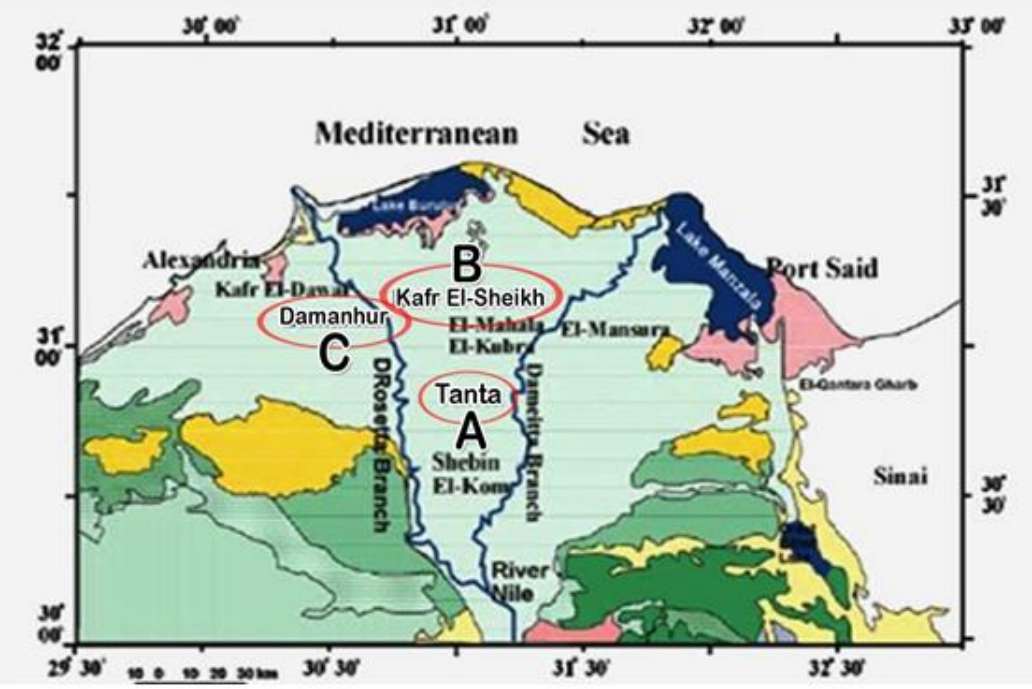
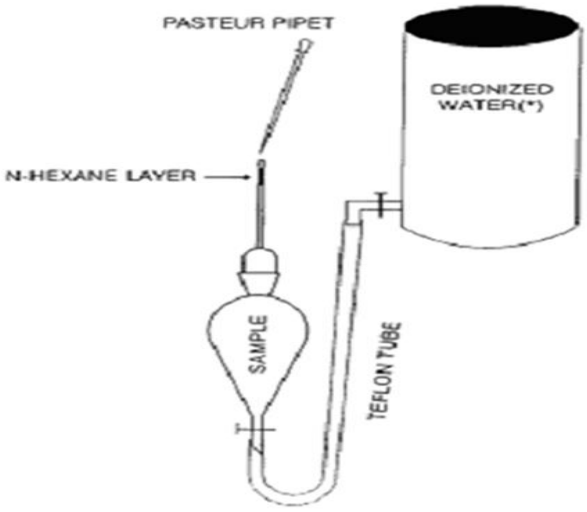


Figure 5: Handmade apparatus for mLLE and trace enrichment of pesticide residues in water samples under investigations.



For qualitative and quantification analysis in our laboratories GC-ECD/FID/FPD, GC-MS (ITD) were used as analytical tools. On the basis of these analytical tools and the previously mentioned procedures for trace enrichment, several muliti- residual analytical methods were developed and validated in our laboratories according to the international rules [15]. These analytical methods were simple and demonstrates good accuracy, sensitivity selectivity, precision to be applied successfully for analysis of pesticide residues of some Ops and OCs in water

samples [4-13]. The resulting residues data were compared with the maximum residual levels (MRLs) set by WHO [1].

Conclusion

In conclusion our analytical methods are fulfills the principles of green chemistry (green analytical chemistry) according to [16,17], we are using a small amounts of solvent ,waste generation is low, doing fast and easy, save time and money, safe for analytsts, using multiresidues technique is consuming low energy, in our laboratories the overall performance of analysis was improved. Finally it can be said that our analytical methods for residues analysis of pesticide chemicals in water samples in our laboratories is suitable for sustainable development of agriculture in Egypt.

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