SPATIAL AND TEMPORAL VARIABILITY OF DDT AND ITS METABOLITES IN THE SEDIMENTS OF A BACKWATER - PADDY GROWING AREA OF KERALA, INDIA.

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Introduction

The occurrence of DDT and its metabolites in aquatic systems is of major concern worldwide. Therefore, monitoring of aquatic environment, in order to verify whether inadmissible levels of pesticides are present, is highly important[1]. Like many other nations in Asia, India is predominantly an agricultural country. In the State of Kerala, rice is the predominant cereal crop in which the study area viz. Kuttanad area accounts for more than 20% of rice production. The use of pesticides in rice is more in comparing with other crops. The backwaters of Kuttanad situated on the southwest of India, is one of the typical estuaries like many other major estuarine systems. The Kuttanad backwater is also subjected to increasing human activities and receives huge amounts of pollutants from agricultural run-off, domestic sewage works, storm water channels, coconut husk retting yards, fishery industries etc. Kuttanad is known as the 'rice bowl of Kerala', and as a result, significant amounts of DDT like pesticides were used in this area also for the control of pests of paddy, before the banning of this pesticide for agriculture. So this study is aimed to quantify the abundance of DDT and its metabolites in the Kuttanad backwaters to confirm the accumulation of DDT and its metabolites from the DDT formulations, which were widely used in these regions for the malaria eradication programme, and also the fact that these compounds are highly stable with low degradability.

Materials and Methods

The study area, backwaters of Kuttanad, is a part of Cochin estuarine system, situated in Kerala, India, between 9° 28' – 10° 10' N and 76° 13' – 76° 31' E and is one of the largest estuarine systems in the south-west coast of India (Figure 1). Kuttanad is the deltaic formation of four river systems which drain westwards from Western Ghats into the southern part of Cochin backwaters. The hydrographic features of Kuttanad backwaters are mainly controlled by the discharges from river systems. Kuttanad is contributing nearly 20% of the total rice production in the Kerala state. The total area of Kuttanad region is estimated as 1,10,000 ha which comprises of 28% dry lands, 60% wet lands and 12% of other water bodies such as lakes, rivers, channels etc. About 55,000 ha of the wet lands are available for paddy cultivation in Kuttanad. Commissioning of Thanneermukkam barrier in 1976 paved the way for two crop cultivation in most of the low lying lands in Kuttanad. The aquatic system was highly productive and contained high fishery resources. Thanneermukkam bund was commissioned in 1976 for regulating the saline water intrusion into Kuttanad paddy fields during December to March and thereby for protecting the 'Punja crop'. The shutters of the barrier remain open during the monsoon period so as to facilitate the evacuation of flood water. However, alterations in the operating schedule such as prolonged closure period brought in some adverse effects in that area. The deterioration of the water quality after the construction of Thanneermukkam bund is one of the major problems facing in Kuttanad also by the tidal intrusions of saline waters from Cochin estuarine system[2].

Sediments were collected using a stainless steel Van-Veen grab. From each location, three grab full of sediment had been collected. The top 5 cm layer sediment samples were homogenized after removing the decayed leafy particles and shells and were stored in closed glass containers. The samples were stored at –20° C till analyses were performed. DDT and its metabolites in sediments were extracted using hexane – acetone mixture and analyzed by gas chromatography[3]. The extract was cleaned up by adsorption-chromatography (using florisil) and concentrated in Kuderna-Danish concentrator and analyzed the sample in gas chromatograph in ECD detector. Sediment samples were fortified with known concentrations of standard organochlorine pesticides in ethyl acetate solution and carried out the same procedure as for sediment samples for the determination of extraction efficiency. Mean recoveries of all organochlorine pesticides were between 75% to 110%. The separation and quantification of the pesticides were performed with the Perkin-Elmer XL Gas Chromatograph fitted with electron capture detector (ECD), and coupled with a 1022- PE-Nelson Integrator. The details of column used and chromatographic conditions are: Column : DB-5 fused silica capillary column by Perkin – Elmer (30m x 0.50mm I.D., 0.25µm film thickness), Column temperature : 180°C for 4 min, 180° to 260°C at 4°C per min, and 260°C for 30 min. Injector temperature : 250°C, Detector (ECD) temperature: 375°C, Carrier, Helium (flow rate): 5.0 ml/min, Make-up gas (flow rate): 30 ml/min (5% methane in argon). Identification and quantification of pesticides were accomplished using reference solutions of analytical grade pesticides, supplied by EPA, USA and Supelco Inc (USA). The initial calibration of GC was carried out by injecting, suitable amounts of standard pesticide solutions. Analysis of the solvent blanks confirmed the absence of any of the pesticides under investigation in the solvent. The analytical reproducibility was checked by triplicate measurements. 0.5 µl to 2.0 µl samples were injected in previously conditioned LC. Statistical analyses of the data were done wherever necessary.

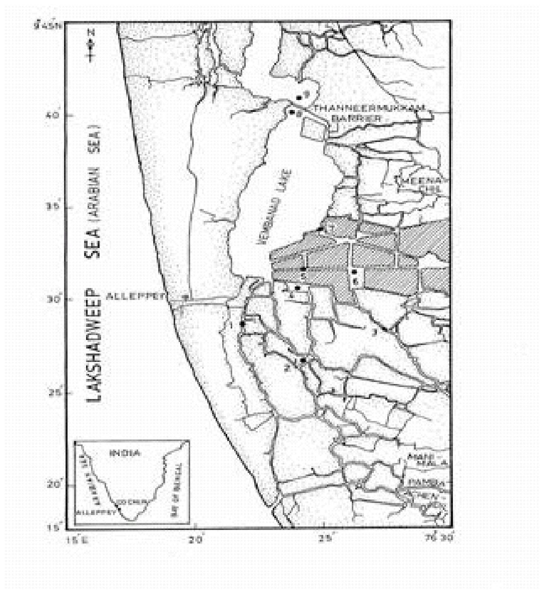

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Figure 1. Study area and location of sampling sites

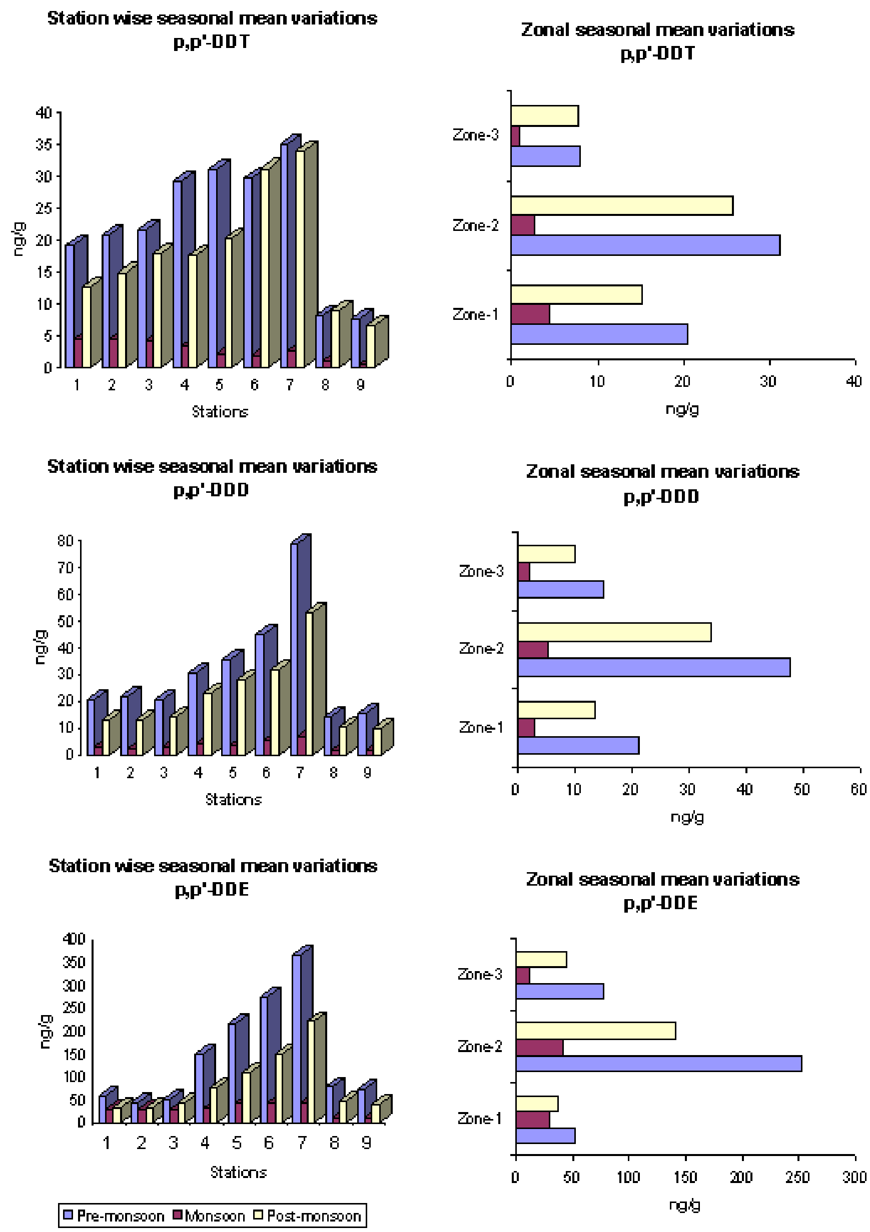

Figure 2. Temporal and spatial variability of DDT and its metabolites.

Results and Discussions

The data were pooled into three seasons (monsoon, pre-monsoon and post-monsoon) for getting reliable trends for explaining the seasonal variations of DDTs (Figure 2). These classifications were based on the rainfall data prevailing in the study area. Considering the salinity distributions, geographical characters and the nature of various human activities prevailing in this area, the study area was divided into three zones. Stations 1 to 3 constituted zone 1, the zone 2 contains stations 4 to 7 and the stations 8 and 9 forms the zone 3. In all seasons, zone 1 showed riverine character. The runoff from the four rivers influenced these stations more prominently. The municipal effluents also have a contribution in polluting this zone. Zone 2 was fresh water dominated zone in monsoon and post-monsoon seasons, but in pre-monsoon, the zone showed estuarine character. Zone 3 is estuarine in nature in pre-monsoon and post-monsoon seasons.

The study revealed the following:

. The main sources of DDT pesticide in the Kuttanad backwaters are the agricultural land run-off from the paddy fields ‘Padashekarams” and the discharge of water from the major river systems,

· In Kuttanad waters, DDE was the major individual metabolite seen throughout the study area. The high concentrations of these compounds may be attributed to the use of DDT formulations for National Malaria Eradication Programme.

· The distribution patterns of DDT and its metabolites in the sediments were dependent on the distributions of organic carbon of the sediments and also the nature of the sediments. The organic carbon distribution and nature of the sediments pattern in the surface sediments were mainly related to the tributary runoff and the anthropogenic inputs.

· Considerable quantities of DDTs were deposited into bed sediments due to low salinity during the early stage of estuarine mixing.

· Data obtained from the present study are useful for an understanding of the contamination dynamics of the different organochlorine pesticides present in the sediments of Kuttanad backwaters. The higher levels of DDTs reported in this study may be attributed to the earlier use of this pesticide due to its cheap cost, broad-spectrum activities, economic constraints and ignorance about their deleterious effects.

· Strict regulations for the use of pesticides in agriculture, wastewater discharge from agriculture, and municipal sewage system are absolutely essential to keep the estuarine/marine environment clean and sustainable.

References

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