A REVIEW ON PROFILE OF DDT AND HCH IN VARIOUS ENVIRONMENTAL COMPONENTS IN INDIA

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ABSTRACT

Pesticides are the chemicals which are used to kill the various pests like insects, flies, weeds, unwanted herbs, fungi and bacteria. The major concerns about pesticides have been raised due to health risks ensuing from occupational exposure and from residues in soil, water, human blood, milk, grains and other food items. Among all types of pesticides two organochlorine pesticides viz DDT and HCH were widely used in India for the control of mosquitoes under National Malaria Eradication Program. Due to versatile action these pesticides were also extensively used in houses and in agriculture. DDT and HCH remains in the environment for longer time and get accumulated in the food chain. These chemicals also transported from one place to another by air drift and also undergoes the process of cold condensation in colder regions that results in increase in half life in temperate regions. As HCH id completely banned in India while DDT can be used under malaria eradication programme but these pesticides are still detected in various environmental components. The water, air and soil get contaminated with pesticides through runoff, spray drift and leaching process whereas harmful effects on wildlife, plants and non-targeted organisms depend on the toxicity and procedures taken during the application of pesticides. The concentrations of various pesticides in all the environmental and biological samples and effects on living system have been reported across the World. There are so many workers who have also reported the higher levels of pesticides in the components of environment and human more than the prescribed limits of WHO.

Keyword:- *Pesticide, DDT, HCH, Cold Condensation, Organochlorines*

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1. INTRODUCTION

The use of synthetic pesticides started in 1948–49 with the use of DDT for malaria control and HCH for locust control [1, 2]. DDT, an organochlorine pesticides showed its spectacular success in Europe by eradicating human typhus transmitted by body lice. It was also effective against malaria vector as in 1940s. It showed a decisive role in the eradication of malaria from Europe and United states and within a very short time, DDT got a unique position by saving millions of lives and by preventing disease outbreaks than any other manmade chemicals in history. Similar success stories of near eradication of malaria were achieved in early 1960s in India and Sri Lanka [3]

The widespread use of the DDT and HCH has created significant environmental concern. The hazardous nature of these pesticides is due to their toxicity in combination with high chemical and biological stability and a high degree of lipophilicity [4]. These two latter characteristic make the OCPs prone to bioaccumulation along the food chain involving a wide range of trophic levels. Although these compounds banned in many countries, they continue to be found widespread in the environment and biological system. The ubiquitous presence of organochlorine throughout the world, including arctic and Antarctic ecosystem has been explained on the basis of atmospheric transportation of these chemicals by process of global distillation followed by cold condensation.

The source of the contamination of DDT and HCH are the deposit from the application of these chemicals in the agriculture and public health programmes. These also release in to the environment from the manufacturing, storage, processing and transport. Once released in to the environment they are incorporated with soil, sediment, water, air etc. they can either migrate from one component to another or undergo chemical transformation to form non-toxic or non toxic compounds [5]. Soil and sediment serves as the major sink for them water and air provide excellent medium for long range transport. The use of these pesticides results in their release in to atmosphere and aerial transport is the major route of contamination [6].

Most developing countries are located in the tropical belt where high temperature and heavy rainfall are common and these climatic factors may provide the rapid transport of insecticide residues through air and water and ultimately contribute to global contamination [7]. As a result the areas with no histological use of organochlorine pesticides such as Artic and antartic regions have measurable amount of these compounds in water and fish [8, 9]. It has been reported that organochlorine insecticide residues move through the atmosphere from relatively warm region to colder region and condensed in colder region and higher latitude on to vegetation, soil and water bodies. This phenomenon known as the "global distillation effect" could be cause of the high concentration of some pollutants found on earth's arctic regions [10, 11]. Applied pesticides may reach ground water in three basic ways such as by run-off (physical transport of pollutants over the soil surface by rain water), run-in (physical transport of pollutants directly to ground water) and leaching (movement of pollutants through the soil by rain or irrigation water). Soil texture, permeability, organic carbon, degradation, volatility, solubility nature of pesticides and depth of ground water play a vital role in pesticide contamination of ground water [12].

POPs (Persistence organic pollutants) pervade the environment through a variety of media. Pesticides though intended for the target pest species, end up in the food chain, water and air and into non target species and ecological systems. Unintentionally and industrial OCPs are often released in an unregulated manner and are assimilated in to environmental systems owing to their properties of persistence, lipophilicity and volatility. Pesticide exposure to human can be intentional and unintentional. Among unintentional exposure in the environment are the direct toxic effects during application to non target groups like pollinators, predators and wildlife as well as post application hazards due to pesticide residues in food, air and water. These can get into the ecosystem at various junctures such as production, transport, storage and application [4].

2. INDIAN SCENARIO OF DDT AND HCH RESIDUES IN VARIOUS ENVIRONMENTAL COMPONENTS

The concentrations of DDT and HCH were reported in Soil, Sediment, Water, Rain water, Fish and Earthworms from different parts of India.

2.1 WATER

The accumulation of DDT and HCH in the fresh water ecosystem is well documented. DDT and HCH have used in India both agriculture and public health sectors. Although the uses of these pesticides have resulted in increased food production and other benefits, it has raised concern about potential adverse effects on the environment and human health. The greatest potential for unintended adverse effects of pesticides is through contamination of the hydrologic systems, which supports aquatic life and related food chains and is used for drinking water, irrigation, recreation and many more purposes. The persistence of the DDT and HCH in aquatic ecosystem has special significance as they are picked up by aquatic organism like plankton and in the process pesticide residues entered in the food chain.

The water samples of Vellar River and Pichavaran mangroves at Porto Novo, Tamil Nadu State of South India showed the DDT and HCH residues in higher levels from October to February, the alpha-HCH was detected as a dominant isomer for all seasons monitored followed by beta-HCH, and among DDT compounds, p,p'-DDT was the highest in river water except in the dry season when p,p'-DDD showed a higher percentage and in mangroves p,p'-DDE was highest during the wet season and p,p'-DDD during the dry season [13].

The presence of DDT and HCH was reported within permissible limits of WHO in the Yamuna river water samples of Delhi [14]. The organochlorine insecticide residues (DDT and HCH) in the rain water samples were reported from BHEL Township Hardwar. All the samples were found contaminated with HCH isomers and DDT [15]. The levels of HCH and DDT were reported in water samples from two areas under malaria control. One area was BHEL, where the bioenvironmental strategy of malaria control carried out and second was Bahadrabad PHC of Hardwar district where spraying of insecticides in rural and urban area were performed. The results showed that no HCH and DDT detected in water samples of BHEL while their mean concentration of sprayed area was 0.18 and 0.07 µg/l respectively [16]. The HCH isomers and DDT, its metabolites in pond water of the rural areas of Shajhanpur district

(UP) was found contaminated with the mean concentration of HCH and DDT 0.81-2.93, 0.62-4.48 µg/l respectively [17]. Kumari reported the organochlorine pesticide residues in pond water and drinking water samples collected from different locations of Haryana and found the presence of HCH isomers and DDT metabolites in all the samples of water [18].

DDT and HCH contamination of water samples of five lakes Bhimtal, Sattal, Khurpatal, Naukuchiatal and Nainital of district Nainital (1934 msl) situated in Kumaun region and noticed the range of Σ-HCH in Bhimtal, Sattal, Khurpatal, Naukuchiatal and Nainital were 2.66-4.79, 3.22-4.83, 2.59-8.65, 1.34-3.12 and 2.94-3.82 respectively and range of Σ-DDT 14.78-24.74, 2.98-10.84, 4.96-8.82, 2.26-6.05 and 13.43-31.33 respectively [19].

The presence of HCH isomers and high ratio of DDT to DDE in sea water of coastal marine environment of Mumbai India was reported [20]. A study was conducted for the HCH and DDT contamination of water samples from two rural areas of Gujarat, one where the pesticides used for agriculture and vector control programme (site I) and second where pesticides only used in agriculture (site II) and concluded that the DDT and HCH was higher at site I as compared to site II [21]. Mukhrjee and coworkers observed the presence of organochlorine pesticides in the ground water and irrigation water samples from nearby village around Delhi and reported that the levels of pesticides were below the maximum contaminant level as prescribed by WHO [22].

The detection of BHC and DDT in water samples was found in snow fed and rain fed rivers and streams of Kumaun region. The concentration of total DDT was higher in snow fed rivers than rain fed rivers [23]. The wheat and water samples from Jaipur, Rajasthan was found contaminated with various organochlorine pesticide residues of DDT and its metabolites and HCH isomers [24]. The levels of total organochlorine pesticides in Gomti river water samples of in Lucknow were ranged from 0.02-4997.0 ng/L [25]. The presence of various pesticides in surface water and ground water samples of Kanpur North India was reported and found with high concentrations of gamma-HCH (0.259 µ/l) in the water samples of river Ganges in Kanpur and in the ground water samples collected from the various hand pumps located in agricultural and industrial areas [26]. The ground water of the Hyderabad city collected from 28 domestic wells were found contaminated with DDT and lindane, In which DDT and lindane were ranged between 0.15-0.19, 0.68-1.38 µg/l respectively and concluded that the concentrations of pesticides in the water samples were found to be above their respective acceptable daily intake (ADI) values for Humans [27]. The presence of organochlorine pesticide residues in ground water samples of Varanasi, India was also documented [28].

The pesticide residues in the river and canal water of Yamuna in the stretch of Haryana-Delhi-Haryana were reported. The workers found that the beta-HCH, p.p'-DDT, p.p'-DDE and p.p'-DDD had maximum traceability in test samples (95-100%) followed by gamma-HCH, alpha-HCH and o.p'-DDD (60-84%) and o.p'-DDT, delta-HCH and o.p'-DDE (7-30%) [29]. Kumari and coworkers reported the presence of pesticide residues in rain water from Hisar (Haryana) collected during 2002 and found the presence of 13 pesticides in rain water samples, the concentration of organochlorines ranged between 0.041-7.060 ppb with maximum concentration of p,p'-DDT up to 7.06 µg/l [30]. The concentrations of DDT and HCH were reported in ground water of Thiruvallur district, Tamil Nadu, India. The samples were highly contaminated with DDT, HCH, and their derivatives [31]. The monitoring of organochlorine residues in 19 water (ground and surface water) samples of rural as well as urban areas of Pondicherry region India was carried out and found high concentrations of organochlorine pesticides in ground water and surface water [32]. The presence of insecticides (HCH, DDT, endosulfan and cypermethrin) above the regulatory limits in water samples collected from Tube wells of different sites in Haryana were noticed in 80% tube well water samples [33]. In a recent report the total organochlorine pesticide residues ranged between 2.16-567.49 ng/l in Gomti River water of Lucknow [34].

2.2 SOIL AND SEDIMENT

Pesticide dynamics in the environment reveals occurrence and movement of pesticide residues from soil by volatilization [35]. In an investigation of HCH and DDT contamination of soil samples of two areas i.e. BHEL and Bhadrabad of Hardwar, the concentration of HCH and DDT was found higher in Bhadrabad (Insecticides sprayed for malaria control) as compare to BHEL (Bioenvironmental control of Malaria) [15]. The contamination of DDT and HCH in sediment samples reported from ponds of rural areas of district Shajhanpur. The mean range of HCH and DDT were found from 10.82-47.41, 39.69-403.60 µg/kg respectively [16]. The presence of HCH and DDT residues in soils collected from different cropping regions of Haryana were reported [18]. The workers found the contamination of organochlorine pesticides in sediments from the Arabian Sea along the West coast of India [36]. The mean concentrations of DDT ranged between 142 to 2207 µg/kg in sediments were reported from different ponds of Nainital district [37]. The presence of chlorinated pesticide residues in surface sediments from the River Kaveri and Coleroon in Tamilnadu, south India were found where alpha HCH was predominated followed by beta and gamma HCH and pp DDE was high in concentration among DDT metabolites [38].

The residues of DDT in sediments from northeast coast (coastline) of India were reported [39]. The concentrations of DDT and its metabolites (DDTs), HCH isomers (HCHs), in sediment and soil samples collected from South India were reported [40]. The levels of organochlorine pesticides in sediment samples from the coastal marine environment of Mumbai was undertaken to elucidate their distribution in various environmental compartments. The contamination of HCH isomers, dichlorodiphenyltrichloroethane (DDT) and its metabolites were found in all the samples [20].

The contamination of soil collected from rice field by DDTs and HCHs from Dehradun city was observed [41]. Bhattacharya and coworkers investigated the surface sediment samples collected from the Hugli estuary of eastern India for the analysis of organochlorine pesticide residues and reported the sediments contain a considerable amount of HCH isomers and DDT metabolites dominated with beta HCH, pp DDT and pp DDE [42]. The soil samples of agricultural fields were analyzed for organochlorine pesticide residues. The analysis indicated that the soil samples contained organochlorine pesticides DDT, DDD, DDE and HCH. The mean concentration of γ-HCH was 47.35 ppb whereas the concentrations of alpha-HCH, beta-HCH, p-p'DDE, o,p-DDT were 38.81, 1.79, 7.10 and 13.30 ppb, respectively, in the same soil samples [43]. The contamination of soil of Delhi, Haryana and Uttar Pradesh area was reported with mean total HCH (α, β, γ and δ) residues of up to 212.20 μg/kg [44].

Guzzella and coworkers were investigated persistent organic pollutants (POPs) such as HCH isomers, DDT and its metabolites, in surface sediments from the coastal estuarine environment of West Bengal, northeast India and found the range of concentrations of HCH and DDT in the sediments were 0.11-0.40 and 0.18-1.93 ng/g dry weight, respectively [45]. The monitoring of HCHs and DDT and its metabolites in sediment samples from east coast of India were reported [46]. The total HCH and DDT concentration in the sediment sample of coastal environment of Mumbai was ranged of 3.8 to 16.2 and 0.38 to 34.1 ng/g respectively. In the study, the contribution γ-HCH was found almost 55% to the total HCH and DDT has higher mean concentration in comparison to its metabolite DDE and DDD [47].

The status of organochlorine pesticides in soil samples of Indo-Gangetic plains of Unnoa district UP was investigated and the presence of DDT metabolites and HCH isomers in soil samples were reported. The range of total organochlorine pesticide residues were 0.36-104.50 ng/g [48]. The soil samples of Haryana were analysed for organochlorine insecticide residues and found contaminated with HCH (0.002–0.051 μg/g), DDT (0.001–0.066 μg/g)[49]. The levels of organochlorine pesticides residues in sediment samples collected from Gomti River India were analysed and higher concentration was reported [50]. The adsorption and deposition characteristic of lindane (γ-HCH) in different Indian soils were reported [51]. Organochlorine pesticide residues (OCs) such as hexachlorocyclohexane isomers (HCHs), dichlorodiphenyltrichloroethane and its six metabolites (DDTs), and hexachlorobenzene (HCB) in core sediments (<63-mum particle size) from the Indian Sunderban wetland were analysed and reported the pooled mean values of the mass fraction of Σ-HCHs, HCB, and Σ-DDTs in the sediments with mean value of 0.05-12, 0.05-1.4, and 0.05-11.5 ng/g dry weight, respectively [52].

2.3 ORGANOCHLORINE PESTICIDES IN EARTHWORM AND FISH SAMPLES

2.3.1 EARTHWORM

Agarwal studied the metabolism of ^{14}C-DDT in *Pheretima posthuma* and the effect of pretreatment with DDT, lindane and dieldrin [52]. Yadav reported the DDT residues in soil and earthworms collected from the 50 sites in Delhi and found the presence of DDT and TDE in earthworm samples [54]. The levels of organochlorine pesticides in earthworm samples of Delhi were reported with mean concentration of total DDT 37.74 mg/Kg [55].

The toxicity of four insecticides in earthworms was studied by Hans and co-worker [56]. Nair reported that the soil and earthworms of Delhi were contaminated with the DDT and HCH [57]. The dissipation and accumulation of lindane in earthworms were reported [58]. The DDT accumulation in the sediments, aquatic organisms and earthworm in South India were studied [40].

2.3.2 FISH

The residues of organochlorine insecticides have been reported in both fresh water and marine fishes. The organochlorine insecticide (DDTs and HCHs) residues in fish samples of ponds in district shajahanpur (UP) were reported. The HCH and DDT residues in water from ponds without fish were found significantly higher than ponds with fish [17]. The different levels DDT and HCH in the fish sample were reported from east and west coast India [39] and accumulation of DDT and HCH pesticide residues in fish samples were found from the southern part India [40]. Organochlorine (DDT and HCH) concentrations in endangered fish *Tor putitora* and *Schizothrox richardosnii* of Kumaun region were noticed and mean total HCH and total DDT ranged between 0.001-0.006 and 0.013-0.055 μg/g respectively [23]. The levels of organochlorine pesticides and polychlorinated biphenyls in Irrawaddy Dolphins

were reported from the Chilka Lake, India. The predominated pesticide DDT was found with 10,000 ng/g lipid weight in the samples [59]. The monitoring of the blubber from the bottle-nose dolphins, spinner dolphins, humpback dolphin collected from the Bay of Bengal were carried out for HCHs and DDTs and found samples contaminated with considerable amount of pesticide residues [60].
The fish samples of marine environment of Mumbai showed the presence of DDT and HCH in good amount [47]. The fish samples collected from the different locations of Calicut region, Kerala were found contaminated with highest amount of organochlorine pesticides. Most of the residues were found in the edible part of fish which may transfer to human after eating [61].
The contamination of fish samples of Gomti river, with organochlorine insecticide were reported with the range value of 2.58-22.56 ng/g with dominance of alpha HCH, beta HCH and pp- DDE in total OCPs concentration [62]. The levels of DDT and HCH were determined in five freshwater fish species in Punjab State, India and it was noticed that the DDTs were the predominant organochlorine contaminants in all species with pp DDT and pp DDE and HCH isomers also found at lower levels in fish species. The alpha-HCH was the dominant isomer of HCH in all fish species followed by gamma-, beta- and delta-HCH [63].

3. CONCLUSION

In today's world, when the efforts to save our planet earth and its ecology from harmful effects of man's abuse of toxic and polluting materials are at peak, the continued use of pesticides having adverse impact on environment needs to be reviewed seriously. Lots of harm has already been done to the environment by widespread and uncontrolled use of organochlorine pesticides. But unfortunately, notwithstanding the adverse effect caused by these chemicals, their use/demand has been increasing in developing countries. India offers a representative example where organochlorine insecticides DDT and HCH have been extensively used in India in agriculture and public health programme. Due to their stability and long term persistence in the environment these residues enter the human system either through food-chain or direct exposure and store after partial metabolism. In all environmental components these compound persist for longer period. Although the HCH is completely banned both in public health and agriculture, Whereas under the Stockholm Convention DDT is banned worldwide for use in agriculture, but it can still be used in developing countries for disease vector control, particularly against the mosquito carrying malaria. The use of DDT may affect the human health of the region where it is to be used to control of mosquito. There are chances of illegal use of DDT in house and agriculture as it is a cheap pesticide. There is a n eed of time to search new plant based formulations and other alternatives which are eco-friendly and biodegradable.

4. ACKNOWLEDGEMENT

The authors are grateful to the Vice-Chancellar Amity University Madhya Pradesh, Gwalior for providing necessary facilities and support for study.

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