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Organochlorine Pesticides in Human Milk: A Recap

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Introduction

The Challenge for producing more food for the ever-increasing population of the globe by proper management of crop pests and control of vector-borne diseases necessitated the application of more pesticides on the earth. The pesticides are poisons, of course, else they would not be useful in controlling insects, rodents, and other undesirable animals and plants. Pesticides may be more specifically identified as insecticides (insects), herbicides (weeds), fungicides (fungi and molds), rodenticides (rodents), acaricides (mites), molluscides (snails and other mollusks), miticides (mites), larvicides (larvae), and pediculocides (lice). In addition, for regulatory purposes, plant growth regulators, repellants, and attractants (pheromones) often also fall in this broad class of poisons. Therefore, the pesticide may be defined as any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest. Pesticide exposures include (1) accidental -unintentional and suicidal poisonings-intentional (2) occupational exposure (happens during manufacturing, mixing/loading, application, harvesting, and handling of crops); (3) bystander exposure to off-target drift from spraying operations; and (4) the general public who consume food items containing pesticide residues of chemicals. In other words, pesticide research is a continuous process for humanity, better living and an improved future. The historical development and projected future underscore the identification and isolation of newer molecules and formulations in the pesticide industry.

The economy of our country is directly related to the quality and quantity of its agricultural production. Our prime need is to sustain the strong agricultural base to balance food production and our multiplying population. Agriculture provides subsistence to the rural and a large segment of the urban population. The measures taken by the Indian government have brought the country to the point of self-sufficiency in food grains. The production of agricultural raw materials such as cotton, rubber and jute also has increased, leading to economic growth and earning of foreign exchange. As per the National Council of Applied and Economic Research (NCAER), a sizeable proportion (15-20%) of the total production of our harvest is destroyed by pests in our country. This emphasises the paramount importance of pesticides in India in preventing loss and enhancing production. Besides agriculture, pesticides are important for the public health programme to check vector-borne diseases.

Pesticides promote health directly through control of insect-vector-borne diseases and indirectly through increased and improved food and fibre agricultural production. The more widely used modern synthetic insecticides are the chlorinated hydrocarbons, organic phosphorous and carbamate groups of compounds. Although there is considerable overlapping in toxicity between these groups, on average, the acute toxicity of the organic phosphorous groups is somewhat greater than that of the chlorinated hydrocarbon compounds. However, due to their greater stability, the chlorinated hydrocarbon compounds are considerably more of a residue problem than other materials. Therefore, it is ironic that organochlorine compounds target more emotional criticism and learned controversy than almost any other biological discovery. Some are notoriously persistent in the environment and can be a real hazard to wildlife, and many believe, a potential hazard to man. In addition, their use has led to the indiscriminate killing of beneficial and harmful insects and, increasingly, to the development of insect resistance. The latter reason, in itself, is sufficient justification for the current policy of using organochlorine compounds for specific purposes rather than as general all-purpose insecticides. The organophosphorus and carbamate insecticide have largely replaced them for many aspects of crop protection in numerous countries.

The chlorinated hydrocarbon insecticides were developed during and immediately after World War II. The prototype compound for this category is DDT. The insecticidal activity of DDT was discovered in 1939 by Dr. Paul Mueller, a feat that won him a Nobel Prize. Pesticides play a major role in controlling vector-borne diseases, which represent a major threat to the health of large human populations. When introduced in 1942, DDT appeared to hold the immense promise of benefit to agriculture and public health by controlling vector-borne diseases. However, because of its bioaccumulation in the environment and its effects on bird reproduction, DDT was eventually banned in most countries by the mid-1970s. When DDT was banned in 1996 in South Africa, less than 10,000 cases of malaria were registered in that country. By 2000, the number of malaria cases had increased to 62,000, but with the reintroduction of DDT at the end of that year, cases were down to 12,500[1]. Excessive loss of food crops to insects or other pests contributes to economic loss and possible starvation.

In developed countries, pesticides allow abundant, inexpensive, and attractive fruits and vegetables and grains. In addition, some DDT analogs also have or have had some importance as insecticides, including methoxychlor, rhothane (DDD or TDE), Kelhen, and chlorobenzilate. Although of no value as insecticides, the other two DDT derivatives are important because of their occurrence as biotransformation products of DDT in men and other species. These metabolites are ethylene (DDE) and acetic acid (DDA) derivatives of DDT. Other chlorinated hydrocarbon insecticides of universal importance are benzene hexachloride (BHC), particularly its purified gamma isomer popularly known as Lindane; toxaphene, chlordane, heptachlor, Aldrin, dieldrin and endrin. Consideration of pesticides must balance the benefits versus the possible risks of injury to human health or degradation of environmental quality.

Humans and animals are constantly exposed in their environment to a vast array of chemicals, including pesticides that are foreign to their bodies. These foreign chemicals or xenobiotics can be of natural origin, or they can be artificial. The more lipophilic compounds like organochlorine pesticides are readily absorbed through the skin, across the lungs, or through the gastrointestinal tract. Constant or even intermittent exposure to these lipophilic chemicals could result in their accumulation within the organism unless effective means of elimination are present.

For decades, Persistent Organic Pollutants (POPs) have been recognised as important toxic environmental contaminants killing our mother nature. Although many different forms of POPs may exist, they are organic compounds of mainly anthropogenic origin characterised by their lipophilicity, long unwanted and unwarranted environmental persistence and extensive and long-range transport. The group consisting of intentionally and unintentionally produced compounds of POPs includes two types of important compounds: halogenated hydrocarbons and polycyclic aromatic hydrocarbons. Organochlorines family are the most important and persistent groups of all the halogenated hydrocarbons, including organochlorine pesticides(OCPs), polychlorinated biphenyls (PCBs), polychlorinated dibenzop-dioxins/furans (PCDD/F), which are in the first group of 12 POPs whose production and emission are to be reduced or eliminated in all over the world according to Stockholm Convention [2].

Due to the intensive usage worldwide in agriculture and the public health sector, OCPs have played an important role in the last few decades in our environment and daily life. OCPs are persistent, broad-spectrum toxicants and sequestered in lipid-rich tissues where their long half-life results in the accumulation with age [3]. Some OCPs such as dichlorodiphenyltrichloroethane (DDT) has been transported throughout the global environment for many decades because of their long persistence. Their residues are present in the air, soil, water and sediment even after several applications [4], [5]. Although the application of OCPs has been outlawed for a considerable period in many countries since the1980s, the residues continue to impact the environment and its ecosystems significantly. Secondly, in developing countries or third-world countries, OCPs are still the major pesticides used in agriculture and the public health sector because of the cost-benefit ratio.

The terrifying fact is that we have largely overlooked the darker side of these chemicals as OCPs are reported to be carcinogenic [6],[7] mutagenic [7],[8] teratogenic [8],[9] immunosuppressive [10],[11] create endocrine dysfunction such as hypothyroidism or high estrogenic activity [12],[13] disturb reproductive processes [14],[15] growth depressants [16],[17] induces several psychogenic and neurogenic abnormalities in adult stages [18],[19], and are associated with abortions, premature deliveries, stillbirths and infants with low birth weights [20]-[23]. OCPs have been in use in India nearly for half a half-century now. Even after having clear cut evidence suggesting that these chemicals can eliminate entire species from the planet, the annual consumption of pesticides in India is about 85,000 tons, of which OCPs comprise the bulk [24]. Therefore, today, pesticides, particularly insecticides, are perhaps the most ubiquitous of the potentially harmful chemicals encountered in the environment.

Since the last century, it has been known that maternal milk sometimes may contain chemical contaminants that could adversely affect nursing infants. Such experiences came mainly from cases of exposure to occupational chemicals or drugs. Since 1950, it has been known that human milk may contain potentially hazardous persistent environmental chemicals in concentrations higher than in cow's milk [25]. These findings have given rise to considerable concern among paediatricians, who must weigh possible and potential hazards against the well-known benefits to newborns, nutritional status, social relationship between mother and child, and the prevention of infant diseases.

Most contaminants found in human milk are fat-soluble substances that will be detected mainly in the fatty phase of the milk. Suppose the human exposure to such chemicals is high. e.g., in some occupational situations, this fat solubility and the degree of ionisation and molecular weight are certainly the most important properties determining the occurrence of chemical contaminants. However, even the low exposures to environmental chemicals can result in the accumulation and get reflected as residues in human milk if these substances have a high degree of environmental and metabolic persistence, which, together with high-fat solubility, gives them an ability to be bioaccumulated in organisms and biomagnifies through natural food chains. The idea behind most investigations of chemical contamination of human milk has been to elucidate the infant burden of those chemicals from nursing. Such studies, however, may also be used as a general biological monitoring tool. As a result, it is possible to encircle pollution sources and prevent further exposures and, hopefully, any adverse health effects on humans.

Scenario

Assessment of human exposure to environmental persistent organic pollutants such as organochlorine pesticides (OCPs), polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins/furans (PCDD/Fs), and polycyclic aromatic hydrocarbons (PAHs) based on the levels in human breast milk provides a reasonable tool not only to assess the contaminant burden in mothers but also to assess potential exposure of breast-fed neonates.

As human beings are placed at the top of most food chains [26], it is, therefore, not surprising that human adipose fat and milk fat usually have more than ten times higher levels of persistent chlorinated pesticides and PCBs as compared to milk fat from cows [27]-[29]. The low level of contamination of cow's milk may be further explained by the cow's daily and continuing mobilisation of fat and the contaminants therein, followed by excretion with the milk [27]. Milk secretion is the most important route of excretion of persistent compounds in human beings and other mammals[30]-[33].

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The first recognition that environmental chemicals may contaminate human breast milk came with the findings of Laug and coworkers (1951), during that the milk from normal and healthy black American women contained considerable amounts of the organochlorine insecticide, DDT [34]. Since then, many investigations on contamination of human milk have been made in countries worldwide, and DDT, together with some other organochlorine pesticides, has been detected and determined in most of these investigations. The contaminants found most frequently in human milk have been DDT, its main metabolite DDE, hexachlorocyclohexane, dieldrin and heptachlor epoxide. Among the more locally found contaminants are the organohalogens, such as Aldrin, heptachlor, mirex, oxychlordane, t-nonachlor, pentachlorobenzene, hexachlorophene, perchloroethylene and halothane. Most human milk monitoring studies have concentrated on analysing a few compounds in the milk, mainly the organochlorines DDT, DDE, HCHs, dieldrin and heptachlor epoxide.

The newborns are not simply small adults is worth reiterating, albeit trite. They differ morphologically, physiologically and biochemically from adults. For example, the neonate's central nervous system is only partially developed and is a site of rapidly differentiating and highly mobile cells. Similarly, the physiology of the hypothalamic/ hypophyseal axis is undergoing rapid and permanent change. It is exquisitely sensitive to the negative feedback effects of gonadal steroids but quickly loses this responsiveness. Other physiological control systems are undergoing a similar change. Even the metabolic fuel differs; newborns operate on fat, adults on carbohydrate. Of great toxicological importance is the immaturity of the neonate's hepatic drug - metabolising enzyme system. The activity of this system is very low in newborns and, in the rat, the various enzymes do not reach adult levels until 30-50 days after birth, i.e., at or after puberty. Because of such differences, the neonate and the adult frequently respond differently to pesticides and other agents. This difference is not necessarily predictable. It may be quantitative, either greater or lesser in the neonate, or qualitative, and must be determined empirically. The response will depend upon a host of pharmacodynamic factors, which can be conveniently considered the innate responsiveness of the target tissue(s) and upon pharmacokinetic factors that determine how much of the agent reaches the responsive tissue and for how long it remains.

Water comprises the major part of milk, typically from 87 to 95% [35]. The protein content of human milk is relatively constant at about 0.9% (W/W), and the essential amino acid requirement is met [36], [37]. The content of carbohydrates, mainly lactose, is 6.5 to 7.4%with little variation [38]. The fat content probably is the most variable nutrient. This variability is very important to consider because most organic pollutants detected in human milk are fat-soluble and occur mainly in the fatty phase of the milk. On reviewing the literature, in most of the studies around the world, the results are usually given on a fat milk basis. This is useful in comparing monitoring results, seeing the correlation between milk fat and residue deposition as both are directly proportional to each other.

Human milk is the primary and the potent source of infant nutrition. It is rich in fat and stands at the end of the food chain. Given their lipophilic nature, pesticides could accumulate in milk in alarming concentrations. Since the OCPs are lipid-soluble and tend to accumulate in the food chain and store high concentrations in tissues and lipid-rich organs such as adipose tissues and the liver. Human milk is the most important and indispensable food for the newborn; during lactation, fat mobilisation could take place from adipose tissue and therefore, organochlorine compounds are mobilised and excreted together with the milk. Thus, milk secretion is the most important route for a woman to shed the body burden of pesticides, mainly OCPs. Therefore, human milk can be used as an evaluation index of environmental contamination by these chemicals. However, the main objective of its analysis is to determine the amounts ingested by children, who, without a doubt, have to face other sources of contamination during their lives.

India

In India, although per capita consumption of agrochemicals is much less than that in other developed countries, the tendency to accumulate them in body tissues and fluids is relatively high [39]. It has been reported elsewhere that Indians possess the highest body burden of organochlorine pesticides [40]. Many reports from different parts of India have drawn attention to the pesticide burden in human milk (Table 1).

Table1.Organochlorine Pesticide residues in Human milk from different parts of the World up to the Year 1980 (ppm).

City	Year	Σ DDT	Σ HCH	Reference
Agra, UP	NA	0.175	0.127	Kumar *et al.*, (2006) [41].
Ahmedabad, Gujarat	1988	6.500	ND	Jani et al., 1988. [42].
Bangalore	1985	0.053	0.014	Ramakrishnan *et al.*, 1985[43].
Chennai, Tamil Nadu	2003	1.200	4.500	Subramanian *et al.,* 2007 [44].
Delhi	1986	0.114	ND	Zaidi *et al.*, 1989 [45].
Delhi	1997	ND	0.380	Banerjee *et al.*, 1997[46].
Delhi	2006	1.500	0.340	Devanathan *et al.*, 2009[47].
Dibrugarh, Assam	2010	2.870	2.330	Mishra and Sharma (2011) [48].
Karnal, Haryana	1985	0.190	0.032	Ramakrishnan *et al.*, 1985[43].
Kolkata, W.B.	1985	0.114	0.031	Ramakrishnan *et al.*, 1985[43].
Kolkata, W.B.	2005	1.100	0.670	Devanathan *et al.*, 2009[47].
Kolkata, W.B.	2005	0.665	0.265	Someya *et al.*, 2010[49].
Kolkata, W.B	2005	1.150	0.690	Devanathan *et al.*, 2009[47].
Lucknow, UP	1980	0.127	0.107	Siddiqui *et al.*, 1981[50].
Lucknow, UP	1980	0.523	0.202	Saxena & Siddiqui, 1982[51].
Lucknow, UP	1985	0.140	0.103	Siddiqui & Saxena., 1985[52].
Mumbai, Maharashtra	1985	0.224	0.053	Ramakrishnan *et al.*, 1985[43].
Mumbai, Maharashtra	2006	0.450	0.220	Devanathan *et al.*, 2009[47].
Mumbai, Maharashtra	NA	0.510	0.289	Sharma *et al.*, 2001[53].
Nagaon, Assam	2010	3.210	2.770	Mishra and Sharma (2011) [48].
Punjab	1980	0.510	0.195	Kalra and Chawla (1980) [54].

*** Year of Publication; ND- Not Detected*

In a report from Agra, UP, [30], total DDT was reported to be 0.175, and 0.127 total HCH reported [41]. In a report from Ahmedabad, Jani and his colleagues (1988) [24] reported contamination of human milk with 1.1 ppm of p, p' -DDT and 5.4 ppm of p, p' –DDE [42]. Ramakrishnan and his colleagues (1985) [43] reported a total HCH and total DDT from four major cities of India. The concentration of total HCH was found to be 0.032, 0.014, 0.031 and 0.053 ppm in Karnal, Bangalore, Calcutta and Mumbai, respectively. Similarly, the concentration of total DDT was found to be 0.190, 0.053, 0.114 and 0.224 ppm in the respective cities. In research from Chennai, Tamil Nadu, total DDT was reported to be1.200, and total HCH was 4.500, which are quite alarming[44]. There are three reports from Delhi, Capital of India Delhi, one conducted in 1986 reported 0.114 of total DDT [45]. The second was conducted in the year 1997, which reported 0.380 of total HCH [46]. The third one was conducted in 2006 and reported total DDT-1.500 and total HCH -0.340 [47].In a report from Dibrugarh, Assam, in the year 2010, total DDT was reported to be 2.870, and total HCH was 2.330 [48]. There is a report from Karnal, Haryana, which mentions that 0.190 of total DDT and 0.032 of total HCH found in the human milk in the year1985 [43]. It's good to mention here that there are four reports from Kolkata, W.B on the residues of OCPs in women milk. In 1985, the reported value of total DDT was 0.114, and total HCH was 0.031[43]. In 2005 total DDT was reported to be 1.100 ppm, and total HCH is reported to be 0.670 ppm. [47]. Someya and his coworkers reported total DDT to be 0.665 ppm and Total HCH to be 0.265 ppm in 2010[49]. Devanathan and his team in the year 2009 reported a total DDT -1.150 and total HCH-0.690[47]. There are three reports from Lucknow, UP on the residues of OCPs in women milk. Siddiqui and his coworkers in the year 1981 reported 0.127 of total DDT and 0.107 of total HCH in women milk [50].In the same year, the residue of total DDT -0.523 and total HCH-0.202 was reported by Saxena & Siddiqui, 1982[51]. There is another report from Lucknow, UP in 1985, wherein Siddiqui & Saxena reported 0.140 of total DDT and 0.103 total HCH in the women milk [52]. From

Mumbai, Maharashtra, there are three reports in the years 1985, 2006 and 2009. The levels of residues reported to be 0.224, 0.450 and 0.510 of total DDT and 0.053, 0.220 and 0.289 of total HCH by different researchers [43], [47], [53].In 2011, Nagaon, Assam, Mishra and Sharma reported 3.210 of total DDT and 2.770 of total HCH in the women's milk [48]. Kalra and Chawla (1980) [54] reported concentration of total DDT and total HCH 0.51 ppm and 0.195 ppm, respectively, from Punjab.

Data on levels of DDTs in human milk in India appeared to follow a significant increase in trend during the last three decades in India, while data of HCHs in human milk is highly scattered. India is unarguably a hotspot of DDT and HCH contamination in the world. Residues in all the researches quoted are often exceeding limits established by some international regulatory agencies. This is due to the elevated use of pesticide POPs in agriculture until recent years and, in the case of DDTs, still ongoing applications for malaria control in India.

World

Besides India, there are reports from worldwide giving an idea about the contamination of human milk with OCPs. An idea about organochlorine pesticide residues in human milk from different parts of the world up to 1980 is cited in Table 2. The conclusion is drawn from the table that the maximum concentration of total DDT is reported in the human milk samples from Guatemala, which is 4.07 ppm [55].

Table1.Organochlorine Pesticide residues in Human milk from different parts of the World up to the Year 1980 (ppm).

Country	Year	Σ DDT	Σ HCH	Reference
Argentina	1977	0.258	ND	Albert, 1981[56]
Arizona	1973 **	0.319	ND	Hagyard *et al.*,1973[57]
Australia (West)	1969-70	0.17	ND	Lofroth, 1968[58]
Australia	1971	0.078	ND	Stacey & Thomas, 1975[59]
Belgium	1969	0.128	ND	Stacey & Thomas, 1975[59]
Canada	1971	0.14	ND	Campos & Marzys, 1979[60]
Canada	1972	0.121	ND	Musial *et al.*, 1974[61]
Canada	1974	0.048	ND	Musial *et al.*, 1974[61]
Canada	1975	0.039	ND	Dillon *et al.*, 1981[62]
Canada	1979	0.044	ND	Mes & Davies, 1979[63]
Czechoslovakia	1969	0.209	ND	WHO, 1979[64]
Chile	1977	0.258	ND	Albert, 1981[56]
Denmark	1974	0.085	ND	Anonymous, (1975)[65]
El Salvador	1973 - 74	0.012	ND	Campos & Marzys, 1979[60]
Finland	1973 - 74	0.058	ND	Vuori *et al.*, 1977[66]
G.D.R	1970	0.16	ND	Engst & Knoll, 1971[67]
Germany	1970	0.112	0.018	Polishuk *et al.*, 1977 [28]
Germany	1970**	0.11	ND	Acker & Schulte, 1970[68]
Germany	1975	0.64*	0. 65*	Fytianos *et al.*, 1985[69]
Germany	1979-81	1.89*	0.454	Deutsche Forschungsgemeinschaft,1984 [70]
Ghana	1972	0.029	0.03	Polishuk *et al.*, 1977[71]
Greece	1983	0.035*	0.015	Fytianos *et al.*, 1985 [69]
Guatemala	1973	4.07	ND	Olszyna - Marzys *et al.*, 1973[55]
Guatemala (City area)	1974	0.48	ND	Campos & Marzys, 1979[60]
Guatemala(rural area)	1974	3.54	ND	Campos & Marzys, 1979[60]
Guatemala	1976	0.378	ND	Winter *et al.*, 1976[72]
Holland	1969	0.046	ND	FDA,1968[73]
Hungary	1975 - 76	0.148	ND	Ari,1977[74]
Iran	1974-76	0.044	ND	Hashemy-Tonkabony & Fateminassab, 1977[75]
Israel	1975	0.046	ND	Polishuk *et al.*, 1977[28]
Italy	1965	0.055	ND	Kanitz & Castello, 1966[76]
Japan	1973	0.089	0.103	Polishuk *et al.*, 1977[28]
Japan	1972 - 76	0.054	ND	Yakushiji *et al.*, 1979[31]
Netherlands	1971	0.049	ND	Stacey & Thomas, 1975[59]
Norway	1970	0.096	ND	Bjerk, 1972[77]
Norway	1975	0.082	ND	Bakken & Seip, 1976[78]
Norway	1976	0.042	ND	Brevik & Bjerk, 1978[79]
Poland	1971 **	0.282	ND	Kontek *et al.*,1971[81]
Poland	1979	0.179	ND	Kontek *et al.*,1971[81]

Rumania	1969**	0.53	ND	Campos & Marzyz, 1979[60]
Spain	1979	0.181	ND	Lora *et al*., 1979[82]
Sweden	1967	0.11	ND	Westoo & Noren, 1972[83]
Sweden	1971-72	0.086	ND	Westoo & Noren, 1972[83]
Sweden	1971	0.114	ND	Stacey & Thomas, 1979[59]
Sweden	1976	0.400*	0.15*	Fytianos *et al*., 1985 [69]
Switzerland	1971	5.500*	ND	Schupbach & Egli, 1979[84]
Soviet Union	1970**	0.21	ND	Suvak, 1970[85]
U.K.	1964	0.127	ND	Stacey & Thomas, 1975[59]
U.S.A(Chicago)	1965 **	0.16	ND	Ouinby *et al*., 1965[86]
U.S.A	1961	0.12	ND	Egan *et al*., 1965[25]
U.S.A	1967	0.07	0.007	Curley & Kimbrough, 1969[87]
U.S.A	1970-71	0.17	ND	Wilson *et al*., 1973[35]
U.S.A	1971 **	0.11	ND	Dyment *et al*., 1971[88]
U.S.A	1974	0.344	ND	Strassman & Kutz, 1977[89]
U.S.A	1976**	0.114	ND	Bradt & Herrenkohl, 1976 [80]
Yugoslavia	1967	0.207	ND	Adamovic *et al.* , 1970(a)[90]
Yugoslavia	1968	0.321	ND	Adamovic *et al*.,1970[91]
Yugoslavia	1971	0.198 & 0.752	ND	Adamovic *et al.* , 1971,1971(a)[92],[93]
Yugoslavia	1974	0.264 & 0.197	ND	Adamovic *et al.* , 1978[94]
Yugoslavia	1978	0.226	0.009	Smit *et al*., 1980[95]

** Fat basis; ** Year of Publication; ND- Not Detected*

After the year 1980, many other reports have come from worldwide, giving an idea about the contamination of whole human milk with organochlorine pesticides. In 1981, Albert and Portales reported contamination of human milk from Mexico City with 0.266 ppm of total DDT [96]. Janneche Utne Skaare (1981) reported concentration of 0.026 ppm of total DDT from Norwa[97]y. A Spain concentration of total DDT is 0.256 ppm in the whole human milk [98]. In 1983, Wickstrom and his coworkers reported contamination of Finnish human milk with 0.031 ppm of total DDT [99]. In Al Omar and his colleagues (1985) findings, human milk samples from Baghdad were contaminated by 0.113 ppm of total DDT, 0.073 ppm of total HCH and 0•017 ppm of Aldrin[100]. In a report from Jerusalem, Weisenberg and his colleagues (1985) reported contamination of human milk with 0.088 ppm of total DDT and 0.012 ppm of total HCH [101]. In a survey study conducted by Stacey and his coworkers (1985) in Western Australia, the value reported for total DDT in the human milk was 0.042 ppm [59]. Al Omar and his colleagues (1986) reported contamination of human milk with 0.762 ppm of total DDT and 0.171 ppm of total HCH [102]. In a monitoring study conducted by Sant Ana *et al*., 1989 in Brazil, the values reported for total DDT and total HCH were 0.025 and 0.030 ppm, respectively [103]. In a report from London, Frank and his colleagues (1988) reported contamination of whole human milk with 0.022 ppm of total DDT [104]. Hernandez and his coworkers (1993) reported contamination of Spanish human milk with 0.659 ppm of total DDT, 0.279 ppm of total HCH and 0.035 ppm of total heptachlor[105]. Ismet Çok and his colleagues in 2011 reported a total of HCH 37.317 and a total DDT 338.383 in the maternal milk from Turkey [2].

The medical importance of DDT in human milk depends entirely on the dosage of the compound received by babies. The average amount of milk secreted daily is about 854 ml for mothers with one child and 950 ml for a mother with twins [94]. The World Health Organization (WHO) and the Food and Agriculture Organization (FAO) have recommended as acceptable daily intake (ADI' S) 0005 mg/kg body weight for DDT, 0.01mg/kg body weight for HCH, 0.0005 mg/kg body weight for heptachlor and heptachlor epoxide and 0.0001 mg/kg body weight for Aldrin [64]. If the daily dose is calculated for the above pesticides, based on the reported values from India and all over the world, then it's quite visible that daily intakes for the above pesticides are far greater than the recommended values, which may have foreboding effects.

Further, the calculation of neonatal intake of these toxic agrochemicals per day based on average weights of the body at birth and the average amount of milk consumed by the baby offers a higher safety factor as it has been reported that an infant consumes about 0.6 litres of milk per day and the average weight of the babies at birth is

3.36 kg [107]. If the daily dose is calculated for the above pesticides, based on the reported values from India and all over the world, these values are almost double the recommended dose, which is dreadful.

What is more seriously to be considered here is the synergistic action of dose-effect relationship of DDT, HCH, Aldrin and heptachlor, which are simultaneously present. It is possible that the dose of either of the detected pesticides which neonates carry may not be harmful, but a combination of two or all of them need to be given serious thought.

Conclusion

Human breast milk offers optimal nutrition for all infants. But unfortunately, numerous studies worldwide have demonstrated that human milk is contaminated with different compounds of mainly anthropogenic origin, such as POPs; the breastfed infant is also exposed during lactation due to the modern world. One of the most important utilities of biomonitoring studies exploring the level of organochlorine compounds in mother milk and adipose tissue samples of various populations is to help understand if there is a relationship between the determined levels and possible toxic actions human body. Some persistent OCPs and some of their metabolites and PCBs, particularly in vivo formed hydroxy-PCB metabolites, are suspected of adversely affecting human reproductive health by acting as endocrine disruptors. The presence of analysed POPs indicated postnatal exposure of the neonates to these potential toxic contaminants. To determine the levels of OCPs and PCBs in humans help clarify toxic effects on human reproductive systems resulting from exposure to these compounds.

Undoubtedly, the above review throws some light on the possible consequences of excretion of toxic agrochemicals through human milk, but this does not imply that breastfeeding is harmful. On the contrary, breastfeeding is the safest and most medically desired form of infant nutrition, leaving out some very special cases. No chemical data are available to assess whatever danger may be associated with the excretion of organochlorine pesticides through the human milk in the quantities reported [34]. Further switching from breast to bottle feeding through the herculean step raised an even greater health risk for babies [107].

It can be concluded that the magnitude of pollution is quantitatively enough to contaminate the food and environment, and the pesticides reach the human body through various sources mainly by absorption from the gastrointestinal tract through the contaminated food chain, are circulated in the blood, stored milk and secreted during lactation resulting in sufficient neonatal intake. Since the pesticides are reported to be carcinogenic, mutagenic, teratogenic, immunosuppressive, induces endocrine dysfunction and high estrogenic activity, disturb the reproductive processes, growth depressants, induces several psychogenic and neurogenic abnormalities in adult stages and are also reported to be associated with abortions, premature deliveries; stillbirths, low birth weight consequences are obvious on the mother and the developing baby. It poses various problems in the management of neonatal nutrition and health. It calls for suggestions like special care in nutrition and the mother's environment throughout life, especially during pregnancy and lactation. It also reflects an urgent need to develop less/non-persistent and more/total biodegradable pesticides and other means by which we can reduce environmental pollution by the pesticides, which poses a risk to human health and jeopardises our future generations.

REFERENCES

[1]. Lucio G. Costa, Toxic Effects of Pesticides, In Klaassen, Curtis D., and John B. Watkins. Casarett & Doull's essentials of toxicology. McGraw-Hill Medical Pub. Division, 2010.
[2]. Çok, I., Mazmanci, B., Mazmanci, M. A., Turgut, C., Henkelmann, B., & Schramm, K. W. (2012). Analysis of human milk to assess exposure to PAHs, PCBs and organochlorine pesticides in the vicinity of Mediterranean city Mersin, Turkey. Environment international, 40, 63-69.
[3]. Haris CA, Woolridge MW, Hay AWM. Factors affecting the transfer of organochlorine pesticide residues to breast milk. Chemosphere 2001; 43, 243–56.
[4]. Barlas N, Cok I, Akbulut N. The contamination levels of organochlorine pesticides in water and sediment samples in Uluabat Lake, Turkey. Environ Monit Assess 2006; 118,383–91.

[5]. Singh RP. Comparison of organochlorine pesticide levels in soil and groundwater of Agra, India. Bull Environ Contam Toxicol 2001;67:126–32.

[6]. Mathur, V., Bhatnagar, P., Sharma, R.G., Acharya, V., Saxena, R.(2002): Breast cancer incidence and exposure to pesticides among women originating from Jaipur, Environment International., Vol. 28, no. 5, pp 331–336, November.

[7]. Ingber, S.Z., Buser, M.C., Pohl, H.R., Abadin, H.G., Murray, H.E., Scinicariello.F.(2013): DDT/DDE and breast cancer: a meta-analysis. Regul Toxicol Pharmacol., vol. 67, no. 3, pp. 421-33.

[8]. Yaduvanshi. S.K, Srivastava. N, F. Marotta. F, S. Jain.S and H. Yadav.H.(2012): Evaluation of micronuclei induction capacity and mutagenicity of organochlorine and organophosphate pesticides, Drug Metab Lett., vol. 6, no. 3, pp. 187-97, September.

[9]. Agency for Toxic Substances and Diseases Registry (ATSDR)/US Public Health Service, Toxicological Profile for 4,4'-DDT, 4,4'-DDE, 4 4'-DDD (Update). ATSDR. Atlanta, GA.1994.

[10]. Repetto. R and Baliga. S.S.(1997): Pesticides and Immunosuppression: The Risks to Public Health," Health Policy Plan., vol. 12, no. 2, pp.97-106.

[11]. Corsinia.E., Sokootib.M., Gallia.C.L., Morettoc.A and Colosiob. C (2013): Pesticide induced immunotoxicity in humans: A comprehensive review of the existing evidence, Toxicology. Vol. 307, pp. 123–135, May.

[12]. Dewailly.E., Ayotte.P., Bruneau.S., Gingras.S., Belles-Isles. M and Roy.R.(2000): Susceptibility to infections and immune status in Inuit infants exposed to organochlorines, Environ Health Perspect., vol.108, no.3, 205–211, March.

[13]. Rathore.M., Bhatnagar.P., Mathur.D and Saxena. G.N.(2002): Burden of organochlorine pesticides in blood and its effect on thyroid hormones in women," Sci Total Environ., vol. 295, no. 1–3, pp. 207–215, August.

[14]. Pant.N., Kumar.R., Mathur. N., Srivastava. S.P., Saxena. D.K and Gujrati. V.R.(2007): Chlorinated pesticide concentration in semen of fertile and infertile men and correlation with sperm quality" Environ Toxicol and Pharmacol., vol. 23, no. 2, pp. 135–139, March.

[15]. Tiemann. U. (2008): In vivo and in vitro effects of the organochlorine pesticides DDT, TCPM, methoxychlor, and lindane on the female reproductive tract of mammals: A review, Reproductive Toxicology., vol.25, no. 3, pp. 316–326, April.

[16]. Colborn.T., Vom Saal. F.S., Soto A.M (1993): Developmental Effects of Endocrine-Disrupting Chemicals in Wildlife and Human," Environ. Health. Perspect, vol. 101, no. 5, pp.378-384, October.

[17]. Mercier. M (1981): Criteria (Dose Effect Relationships) for Organochlorine Pesticides Report, Published for the Committee of the European Communities by Pergamon Press.

[18]. Mactutus, C.F and Tilson, H.A (1986): Psychogenic and neurogenic abnormalities after perinatal insecticide exposure. In: Handbook of behavioural teratology. Ed. by Edward, P.R. and Charles, V.V. Plenum Press, NY, 335-91.

[19]. Van Wendel de Joode.B., Wesseling.C.,Kromhout.H., Monge. P., García. M and Mergler. D. (2001): Chronic nervous-system effects of long-term occupational exposure to DDT, Lancet., vol. 357, no. 9261, pp. 1014–1016, March.

[20]. Saxena, M.C., Siddiqui, M.K.J., Seth, T.D and Krishnamurti, C.R. (1981): Organochlorine pesticides in specimens from women undergoing an abortion, premature and full-term delivery. J. of Anal. Toxicol.5, Jan/ Feb.

[21]. Saxena, M.C., Siddiqui, M.K.J., Bhargava, A.K., Seth, T.D., Krishnamurti, C.R and Kutty, D. (1980): Role of chlorinated hydrocarbon pesticides in abortions and premature labour. Toxicology. 17. 323-31

[22]. Tyagi.V., Garg.N., Mustafa. M.D., Banerjee., B.D and Guleria. K.(2015): Organochlorine pesticide levels in maternal blood and placental tissue with reference to preterm birth: A recent trend in North Indian population, Environ Monit Assess., vol.187, no. 7, pp. 471, July.

[23]. Chen.Q., Zheng.T., Bassig.B., Cheng.Y., Leaderer.B., Lin.S., Holford.T., Qiu.J., Zhang.Y., Shi.K., Zhu.Y., Niu.J., Li.Y., Guo. Y.H., Huand. X and Jin.Y.(2014): Prenatal Exposure to Polycyclic Aromatic Hydrocarbons and Birth Weight in China," Open Journal of Air Pollution, vol.3, pp. 100-110.

[24]. India Environment Portal Knowledge for change, 30/10/1998.

[25]. Egan, H., Goulding, R., Roburn, J., & Tatton, J. G. (1965). Organo-chlorine pesticide residues in human fat and human milk. British medical journal, 2(5453), 66.

[26]. Gochfild, M. (1972): Pesticides and the nursing mother. Paediatrics. 50, 169.

[27]. Tolle, A., Heeschen, W and Bluthgen, A.(1974): Fremdstoffe in Hilchnahrungen Mschr Kindirheilk. 122, 309.

[28]. Polishuk, Z. We, Ron, M., Wasserman. M and Lemesch, C. (1977): Organochlorine compounds in human blood, plasma and milk. Pestic. Monit. J. 10: 121.

[29]. Landoui, J.H and Astolfi, E.A. (1982): Organochlorinated pesticide residue in human milk -Rep. Argentina -10 year monitoring. Paper presented at Int. Synposium. Chemical in the Environment, Copenhagen. Oct. 10-20.

[30]. Yakushiji, T. Re, Koyama, K., Hara, J and Kunita, N.(1978): Long term studies of the excretion of polychlorinated biphenyls (PCB) through the mother's milk of an occupationally exposed worker.Arch. Environ. Contam. Toxicol. 7, 493.

[31]. Yakushiji, T., Watanabe, I., Kuwabara, K., Yoshida, S., Hoi.S., Fukushima, S., Kashimsto, T., Koyama, K and Kunita, N.(1979): Levels of organochlorine pesticides and polychlorinated biphenyls (PCB 's) in mother's milk collected in Osaka prefecture from 1969 to 1976. Arch. Environ. Contam. Toxicol .8, 59 66.

[32]. [32] Jonsson, V. G. K., Ziu, J., Armbeuster, L., Kellehhut, L and Drucker, B.(1977): Chlorohydrocarban pesticide residues in human milk Greater. St. Louis. Missouri.Am.J. Clin.Nutr.30, 1106-9.

[33]. Brilliant, L., Amburg, G.V., Isbister, J., Humphrey, H., Wilcox, K., Eyster, J., Bloomer, A.W and Price, H.(1978): Breast milk monitoring to measure Michigan's contamination with polybrominated biphenyls. Lancet. 11, 643.

[34]. Laug, E.P., Kunze, F.M and Prickett, C.S. of DDT in human fat and milk. Arch. Industr. Higg. 3, 245.

[35]. Wilson, D J., Locker, O. J., Ritzen, C.A., Watson, J T and Schaffner, W. (1973): DDE concentrations in human milk. Am. J. Dis. Child. 125,814-17.

[36]. Hambraeus, L., Lönnerdal, B., Forsum, E., & Gebre-Medhin, M. (1978). Nitrogen and protein components of human milk. Acta Pædiatrica, 67(5), 561-565.

[37]. Jonas. A. (1980): Human milk at different stages of lactation. In Freiver, S and Eidelman, A.I. (eds): Human milk. Its biological and social value 51. Amsterdam - Oxford-princetca: Excepta. Medica.

[38]. Picciano, M.F.(1978): The volume and composition of human milk. Lecture. Int. Symp. on infant and early childhood feeding. Michigan State University, Oct.

[39]. Bindra, O. S. (1971): The magnitude of pesticide pollution in India. Pestic.Annu.Dec, 81.

[40]. Dale. W.E., Copeland, M.F., Hyes, W.J.(1965): Chlorinated insecticide in people's body fat in India. Bull. World. Hith. org. 33,471 - 77.

[41]. Kumar A, Dayal P, Shukla G, Singh G, Joseph PE. DDT and HCH residue load in mother's breast milk: a survey of lactating mother's from remote villages in the Agra region, Environ Int 2006; 32:248–51.

[42]. Jani, J.P., Patel, J.s., Shah, M.P., Gupta. S.K and Kashyap, S.K. (1988): Levels of organochlorine pesticides in human milk in Ahmedabad, India. Intern. Archs. Occup. Environ. Hlth. 60, 111-3.

[43]. Ramakrishnan, N., Kaphalia, B. S., Seth, T. D., & Roy, N. K. (1985). Organochlorine pesticide residues in mother's milk: a source of toxic chemicals in suckling infants. Human Toxicology, 4(1), 7-12.

[44]. Subramanian A, Ohtake M, Kunisue T, Tanabe S. High levels of organochlorines in mothers' milk from Chennai (Madras) City, India. Chemosphere 2007; 68:928–39.

[45]. Zaidi, S.S.A., Bhatnagar, V. K., Banerjee, B.D., Balakrishnan, G and Shah, M (1989): DDT residues in human milk samples from Delhi, India. Bull. Environ Contam. Toxicol. 42,427-30.

[46]. Banerjee BD, Zaidi SSA, Pasha ST, Rawak DS, Koner BC, Hussain QZ. Levels of HCH residues in human milk samples from Delhi, India. Bull Environ Contam Toxicol 1997; 59:403–6.

[47]. Devanathan G, Subramanian A, Someya M, Sudaryanto A, Isobe T, Takahashi S, et al. Persistent organochlorines in human breast milk from major metropolitan cities in India, Environ Pollut 2009; 157:148–54.

[48]. Mishra K, Sharma RC. Assessment of organochlorine pesticides in human milk and

risk exposure to infants from North-East India. Sci Total Environ 2011; 409:4939–49.

[49]. Someya, M., Ohtake, M., Kunisue, T., Subramanian, A., Takahashi, S., Chakraborty, P., Ramachandran, R., Tanabe, S.(2010): Persistent organic pollutants in the breast milk of mothers residing around an open dumping site in Kolkata, India: specific dioxin-like PCB levels and fish as a potential source. Environment International, 36(1), 27-35.

[50]. Siddiqui, M.K.J., Saxena, M.C., Bhargava, A.K., Seth, T.D., Krishnamurti, C.R. and Kutty, D. (1981): Agrochemicals in the maternal blood, milk and cord blood: A source of toxicant for prenates and neonates. Environ. Res. 24, 24-32.

[51]. Saxena, M.C and Siddiqui, M.K.J.(1982): Pesticide pollution in India: Organochlorine pesticides in women, buffalo, and goat milk. Dairy Sci. 65,430 -34.

[52]. Siddiqui, M.K.J and Saxena, M.C. (1985): Placenta and milk as excretory routes of lipophilic pesticides in women. Human. Toxicol.4,249-54

[53]. Sharma S, Pandit G, Sahu S, Fernandez K, Badhwar AR,Mandkar VR. Organochlorines pesticides residue in human milk in Mumbai, India. National Symposium on Environment; 2001. p. 234–337.

[54]. Kalra, R. L and Chawla, R. P.(1981): Occurrence of DDT and BHC residues in human milk in India. Experimentia. 37,404-5.

[55]. Olszyna Marzys, A.E, Campos, M. de. Farvar, M.T and Thomas, M. (1973):Boll Oppenoorth, F.J. (1954): Nature. 173,1000.

[56]. Albert, L, Vega, P and Portales, A. (1981): Organochlorine pesticide residues in human milk samples from Comarca, Lagunera, Mexico. 15,3.

[57]. Hagyard, S.B., Brown, W.H., Stull, J. W., al. Whiting, F.M. and Kemberling, S.R. (1973): DDT and DDE content in human milk in Arizonia. Bull. Environ. Contam. Toxicol.9, 169-72.

[58]. Lofroth, G.(1968): Pesticides and Catastrophe. New Sci.40 .626, 567-8.

[59]. Stacey, C. J., Perriman, W S., and Whitney, S. (1985): Organochlorine pesticide residue levels in human milk, Western Australia 1979-1980. Arch. Environ.

[60]. Campos, M de and Olszyna Marzys, A.F. (1979): Contamination of human milk with chlorinated pesticides in Guatemala and EL Salvador. Arch. Environ. Contam. Toxicol. 8, 43-58.

[61]. Musial, C. J. Hutzinger, O. Zilko, V. and Crockee,J. (1974):. Presence of PCB, DDE and DDT in human milk in provinces of New Bremsiwick and Nova Scotia, Canada. Bull. Environ. Contam. Toxicol. 12,358.

[62]. Dillon, J.C., Martin, G. B and O' Brien, H.T(1981): Pesticide residues in human milk. Food. Cosmet. Toxicol. 19,437.

[63]. Mes, J. Doyle, J.A., Adams, B. R., Davies D. J and Turton, D. Polychlorinated biphenyls and organochlorine pesticides in milk and blood of Canadian women during Lactation. Arch. Environ. Contam. Toxicol. 13, 217-23.

[64]. WHO (1979): Environmental Health Criteria. 9: DDT and its derivatives. Geneva: World Health Organisation.

[65]. Anonymous. (1975): Materiale til arsberetning for 1974. stad sdyrlaegen i odense.

[66]. Vuori, E., Tyllinen, H., Kuitumen,p and Peagnus, A.(1977). The occurrence and origin of DDT in human milk. Acta. Paediatr. Scand. 66, 761-65.

[67]. Engst, R and Knoll, R. (1971): DDT- and DDE-Ruckstande in human milch. Ernahrungs forschung. 16, 569

[68]. Acker, L and Schulte. E. (1970): Deut. Lebensm. Rundsch. 66,385.

[69]. Fytianos, K., Vasilikotis, G., Weil, L., Kavlendis, E and Laskaridis, N.(1985): preliminary study of organochlorine compounds in milk products, human milk and vegetables. Bull. Environ. Contam. Toxicol. 34,504-8.

[70]. Deutsche Forrchungegemeinschaft (DFG) (1984): "Ruckstande und Verunreinigrengen in Frauenmilch, Mitteillung XII der Kommission Zur Prufung Von Ruckstanden in Zebensmitteln ". Verlag Chemie, Weinchaim.

[71]. Polishuk Z.W., Ron, M., Wassermann, M., Cucoss, S., Wassermann, D and Jemesch, C. (1977b): Pesticides in People. Pestic. Monit .J .10, 121 -29.

[72]. Winter, M., Thomas, M., Wernick, S., Levin, S and Taghifaeval, M.(1976): Analysis of pesticide residues in 290 samples of Gautemalan mother's milk. Bull. Environ. Contam.Toxicol.16, 6.

[73]. Food and Drug Administration.(1968): Pesticide Analytical Manual. Vol. Section 211, 13i (2). US Department of Health Education and Welfare.

[74]. Ari, L. (1977): Levels of chlorinated remnants in native, pasteurised and lyophilised breast milk. (In Hungarian) Egeszsegtudomany. 22, 38.
[75]. Hashemy-Tonkabony, S. E., & Fateminassab, F. (1977). Chlorinated pesticide residues in milk of Iranian nursing mothers. Journal of dairy science, 60(12), 1858-1860.
[76]. Kanitz, S., & Castello, G. (1966). On the presence of residues of some disinfectants in human adipose tissue and some foods. (1st results of an investigation conducted in Liguria). Giornale di igiene e medicina preventiva, 7(1), 1-19.
[77]. Bjerk, J. E. (1972). Residues of DDT and polychlorinated biphenyls in Norwegian human material. Tidsskrift for den Norske Laegeforening, 92, 15-38.
[78]. Bakken, A.F and Seip, M.(1976): Insectides in human breast milk. Acta. paediat. Scand. 65, 535-39.
[79]. Brevik, E.M and Bjerk, J .E.(1978): Organochlorine compounds in Norwegian human fat and milk. Acta. Pharmacol. et.Toxicol.43, 59-63.
[80]. Bradt, P.T and Herrenkohl, K.C.(1976): DDT in human milk. What determine the levels 2? Sci. Total. Environ. 6,161-3.
[81]. Kontek, M., Kubacki, S., Paradowski, S., & Wierzchowiecka, B. (1971). Determination of chlorine pesticides in human milk. Pediatria polska, 46(2), 183-188.
[82]. Lora, R.P., Mateache, P. A.H., Villar, L.M.P., Gmenez, R.L., Villarejo, M.J and Perez, J.I. (1979): Plaquicidas Organoclorados enleches humanas espanolas. Rev. Esp. Pediatr. 35, 93.
[83]. Westöö, G., & Norén, K. (1972). Levels of organochlorine pesticides and polychlorinated biphenyls in Swedish human milk. Vår föda, 24, 41-54.
[84]. Schupbach, M. R and Egli, H.(1979): Organochlorine pesticide and polychlorinated biphenyls in Muttermilch. Mitt. Gibiete. lebensm. Hegg. 70,451.
[85]. Suvak, L. N. (1970). DDT and DDE contents in the milk of nursing women. Zdravookhranenie, 13(4), 19-21.
[86]. Quinby, G.E., Armstrong, J.E and Durham, W.F. (1965): DDT in human milk. Nature , 207,4998, Aug 14.
[87]. Curley, A and Kimbrough, R. (1969): Chlorinated hydrocarbon insecticides in plasma and milk of pregnant and lactating women. Arch. Environ. Hlth. 18,156.
[88]. Dyment, P.G., Herbertson, L.M., Decker, W.J., Gomes, E.D. and Wiseman, J.S.(1971): Relationship between levels of chlorinated hydrocarbon insecticides in human milk and serum. Bull. Eviron. Contam. Toxicol. 6, 449.
[89]. Strassmann, S.C. and Kutz, F.W (1977): Insecticide rsidues in human milk from Arkansas and Mississippi, 1973 - 74. Pest. Monit. J. 10, 130.
[90]. AdamoviC, M.V.,Hus, M., Vukcevic, Z and Jovanovic. (1970a): Archives de L Union Medicale Balkanique .8, 55.
[91]. AdamoviC, M.V., Hus. M., Sinojic, M., and DJukic, V.(1970):Hrana i ishrana.11,12.
[92]. Adamovic,M.V., Sokic,B., Hus, M., Vukcevic and Jovanovic. M. (1971): Hrana i ishrana. 12,566.
[93]. Adamovic, M.V., Sokic, B and Petrovic, O. (1971a): Ernaheoungs for Schunj. 16,579.
[94]. Adamovic, V.A., Sokic B and Smiljanski, M.J. (1978): Some observations concerning the ratio of the intake of organochlorine insecticide through food and amounts excreted in the milk of breastfeeding mothers. Bull. Environ. Contam. Toxicol. 20, 280-5
[95]. Smit, M.K., Smit Z and Olei, K. (1980): Organochlorine contamination in human milk from Slovonia Province, Yugoslavia 1978. Pestic. Monit. J. 14:1,1-2
[96]. Albert, L, Vega, P and Portales, A. (1981): Organochlorine pesticide residues in human milk samples from Comarca, Lagunera, Mexico. 15,3.
[97]. Skaare, J.U. (1981): Persistent organochlorinated compounds in Norwegian human milk in 1979. Acta. pharmacol. et. toxicol. 49, 384-89.
[98]. Baluja, G., Hernandez, L.M., Gonzalez., Ma.J and Rico,. Ma.C. (1982): Presence of organochlorine pesticides, polychlorinated biphenyls and mercury in Spanish human milk samples. Bull. Environ. Contam.Toxicol. 28,573-77.
[99]. Wickstrom, K., Pyysalo, H and Siimes, M.A. (1983): Levels of Chlordane, hexachlorobenzene, PCB and DDT compounds in Finnish human milk in 1982. Bull.Environ. Contam. Toxicol. 31, 251-56
[100]. Al Omar, M.A., Tawfiq, S.J and Qgaily, N.A.(1985): Organochlorine residues in human

milk from Baghdad Bull Environ Contam Toxicol 35,65-7.

[101]. Weisenberg, W., Arad.l., Grauer, F and Sahm, Z.(1985): Polychlorinated biphenyls and organochlorine insecticides in human milk in Israel. Arch. Environ. Contam. Toxicol. 14, 517-21

[102]. Al-Omar, M. A., Abdul-Jalil, F. H., Al-Ogaily, N. H., Tawfiq, S. J., & Al-Bassomy, M. A. (1986). A follow-up study of maternal milk contamination with organochlorine insecticide residues. Environmental Pollution Series A, Ecological and Biological, 42(1), 79-91.

[103]. Sant Ana, L.S., Vassilieff, I and Jokl. L. (1989): Levels of organochlorine insecticides in mothers' milk from urban and rural areas of Botucatu, SP. Brazil. Bull. Environ. Contam. Toxicol.42, 911-18.

[104]. Frank, R, Rasper, J., Smut, M.S and Braun, H.E. (1988): Organochlorine residues in adipose tissues, blood and milk from Onatario residents, 1976-85. Canad. J. Pub. Hith. 79, May/June

[105]. Hernandez, L.M., Fernandez, M.A., Hoyas, E., Gonzalez, M.J and Garcia, J.F. (1993): Organochlorine insecticide and polychlorinated biphenyls residues in human breast milk in Madrid (Spain). Bull. Environ. Contam. Toxicol.50,308-15

[106]. Siddiqui, M. K.J. (1982): Biochemical Studies on tissues accumulating pesticides. Ph.D. thesis submitted to the University of Lucknow, India.

[107]. Thacher, S. (1979): Toxic human milk may become a serious global problem. World. Environ. Rept. 5 (18), Aug, 16.