International Journal of Engineering & Scientific Research
Vol.12 Issue 01, January 2024
ISSN: 2347-6532 Impact Factor: 6.660
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

Organochlorine Pesticides in the Cattle Milk from Alwar, NCR of Delhi, India

Mamta Sharma*, Mohnish Mehra & Anil Kumar Chhangani*****
*Associate Professor, Deaprtemnt of Zoology,Raj Rishi Government (Autonomous) College ,Alwar, Rajasthan 301001,India.
**JRF, Environmental Toxicology Laboratory, Raj Rishi Government (Autonomous) College ,Alwar, Rajasthan 301001,India.
***Professor &Head, Department of Environment Science, MGS University, Bikaner 334004, Rajasthan.
Corresponding Author Email: mamta810810@gmail.com

ABSTRACT:

Organochlorine pesticides (OCPs) are a group of synthetic chemicals that have been widely used in agriculture and public health for pest control. However, OCPs are also persistent, bioaccumulate, and toxic to humans and animals. OCPs can contaminate the environment, especially the soil, water, and air, and enter the food chain through various pathways. One of the main sources of human exposure to OCPs is the consumption of dairy products, such as milk, cheese, and butter, which contain OCP residues from the feed, water, and soil ingested by the cattle. The levels of OCPs in cattle milk vary depending on the region, the type of feed, the animal species, and the analytical methods used. Some studies have reported the occurrence and levels of OCPs in cattle milk from different countries, such as Romania, India, Mexico, and Colombia. The most common OCPs detected in cattle milk are hexachlorocyclohexane (HCH) isomers, dichlorodiphenyltrichloroethane (DDT) and its metabolites, heptachlor, aldrin, dieldrin, endrin, chlordane, methoxychlor, and hexachlorobenzene (HCB). Some of these OCPs have been banned or restricted for use in many countries, but they still persist in the environment due to their long half-lives and illegal use. The presence of OCPs in cattle milk poses a potential health risk for consumers, especially for infants and children, who are more vulnerable to the adverse effects of these chemicals. OCPs can cause various health problems, such as cancer, endocrine disruption, reproductive impairment, neurotoxicity, immunotoxicity, and liver damage. Therefore, it is important to monitor the levels of OCPs in cattle milk and other dairy products, and to implement measures to reduce the contamination and exposure to these pesticides. Some of the possible measures include using alternative pest control methods, improving the quality of feed and water, applying good agricultural practices, and enforcing the regulations and standards for OCP residues in food. There are many reports from India and all over the world giving an idea about the concentration of detectable OCPs in the cattle milk but no such report is available from Alwar, NCR of Delhi, Jaipur. A study was, therefore, was planned and conducted in Alwar, National capital Territory of Delhi to assess the OCPs residues in the cattle milk samples using gas liquid chromatography. The results revealed the presence of isomers of HCH, heptachlor, DDT, Endrin, Endosulphan, Chlordane and its metabolites and Methoxychlor, Dieldrin, Aldrin in the water samples analyzed. This is the very first report from Alwar, India on the water contamination of the OCPs residues indicating the pesticide pollution by these xenobiotics, which in turn is a risk to human health and environment as a whole. Secondly, this may be considered as an indication of the transfer of these chemicals from environment to flora and fauna including human and then bioconcentration and bioaccumulation processes may lead to detrimental effects as milk form the important ingredient of the human diet.

KEY WORDS:

Organochlorine Pesticides, Residues, Gas Chromatograph, Cattle Milk, Alwar, NCR of Delhi

INTRODUCTION

The challenge for producing more food for the ever-increasing population of the globe by proper management of crop posts and control of vector borne diseases necessitated the application of more pesticides. The pesticides are poisons of course, or they would not be useful in the control of insects, rodents, and other undesirable animals and plants. In other words, pesticide research is a continuous process for all of us striving for better living and better future. Pesticides, human health and safety of the environmental have been a global concern. Public attention was first focused on the detrimental effects of pesticides use following the 1956 publication of Spector's book "Hand book toxicology" which greatly magnifies the potential hazard of persistent of genetic biologist Dr. Rachel Carson's bool "Silent Spring" Which showed how pesticides had entered the food chain of birds in United State. Hygiene and Public Health, Calcutta, and The Central Plant Protection Training Institute, Hyderabad, Have shown that in India, per hectare consumption of pesticides is quite low in comparison of many developed countries even than our daily food intake is laced with some of the highest amounts of toxic pesticides residues found in world i.e. in India our daily diet contains 0.27 mg DDT[1].Here, it may note that the maximum safe limit of DDT in the daily diet of a person is five microgram per kg body weight that would amount to about 0.3 mg of DDT in the daily diet of an average person, meaning we Indian are touching and often surpassing the upper limit of DDT intake [2]. An Indian ingests 40 times more pesticides with his food than the average American or Englishman. The level in the body fat of the residents of Delhi, for instance found to 26 ppm on an average, the highest in the world, far exceeding the maximum residue limit of 1.25 ppm (Hindustan Times, 3.11.90) Rural population however, face an increased risk of exposure due to characteristic occupational activities like exposure on farms, and non-point sources of environmental contamination (e.g. by consuming contaminated food or drinking water). Moreover, the abysmally low levels of literacy and health unconsciousness along the country side further magnifies the risk factor. The main use of pesticides in the country is in agriculture, food storage and public health sections to combat pests and diseases which effect men. Cosmetic pesticides are also sprayed wantonly on fruits and vegetables in major cities to improve the “look”, methyl parathion on cauliflower gives an extra white look, Bhindi is dipped in copper sulphate to look greener. Out of 123 chemicals, pesticides allowed in India, DDT, IICCI(BHC) and malathion are used in public health programmes. In India, unlike in many developed countries, organochlorine pesticides especially DDT and HCH constitute the 2/3 of the total pesticides consumption because these are ten times cheaper than most other pesticides, easy to handle and attack a wide range of pests [3]. As a result, today food grain such as wheat and rice as well as vegetables and fruits contain varying number of pesticides residues. The latter often becomes an integral part of the food stuff, which means they cannot be removed completely by washing or cooking.

The use of pesticides, mostly DDT in public health commenced in 1953-54 with the initiation of malaria control, programme. Thenceforth, DDT has been used extensively throughout the world, to control arthropod-borne diseases agricultural pests and in forestry application. Because the insecticide dramatically. In India in 1960. about 600 MT of DDT was used in agricultural and 21000 MT for public health. As against this, for public health in 1980, DDT used was 15500 MT and 1900 for 1983-84. With the increased use of the chemicals the world over, negative environmental effects began to be noticed. These included toxicity in non-target organism, bio accumulation, long terms environmental persistence in target pests [4]. DDT has reached even remote places like the Arctic circle and the Antarctica, where there are no farms to use it. Yet polars bears, seals and penguins have it in large concentration in their bodies [1]. Since its introduction in India agriculture, about 575000 tonnes of HCH has been used 500000 tonnes in agriculture and 75000 tonnes in the public health sector to date. The current annual consumption of HCH is nearly 30000 tonnes in agriculture and 6000 tonnes in public health. It forms 60% of the total insecticide consumed in the agriculture sector [5].

The area of confidence in the pest’s control was soon followed by an area of disillusionment. Residues od these persistent insecticides are an integral part of our environment today, being reported in every form of marine, aerial and terrestrial life as well as in the abiotic (air, soil, water) component. The ubiquitous occurrence of organochlorine residues in the environment has led to a reduction of their use in many advance countries which can afford even costlier chemicals and have introduced safer and easily biodegradable pesticides as a measure to check unwanted/unwarranted environmental pollution. DDT, HCH. Ethylene dibromide, methyl parathion etc. Are banned is most of the western countries [2] EPA (Environmental Protection Agency) banned aldrin and dieldrin in 1974 along with most field use of endrin. Paraquet was banned in Unites State in 1983 and in three other countries and its use is restricted in four countries. HCH (Hexachlorocyclohexane) was also banned in the US in 1978 (Time of India. 26.1.93). It is very unfortunate that many of these pesticides which proved to be injurious for human being are still being used in our country in quite higher quantities because of their cost benefit ratio. There is an urgent need to recognised to the consumer's right to information about harmful effects of pesticides. At least 70% of the pesticides handled by the Indian farmer have been declared “excessively toxic” by world health organization. Unfortunately, pesticides are big money often banned in their country-of-origin stocks are dumped on eager to purchase developing nations. It is a known fact that one quarter of all pesticides exported by the United State are not registered for use in the US. They include cancelled or suspended pesticides because they may cause cancer or otherwise endanger human or the environment. A pesticide action group in Paraguay remarks. We do not understand how industrialised countries, producer of pesticides, they do not consume, can allow export to less developed countries. Perhaps we are more resistant human being" (Hindustan Times 3.11.90).

It has been reported in the Time of India, Dated 23rd June 1993 that India government has banned 12 pesticides and also restricted the use of 13 pesticides Dibromochloropane (DBCP), endrin, pentachlerenitrobenzene (PCNB) pentchlorophenol (PCP), toxaphene,eathyl parathion, cholradane, heptachlor, aldrin,paraquet- dimethyl sulphate,nitrogen and tetradifon are banned in India and other 13 pesticides are restricted for thier use in India which includes Aluminium phosphide, hexachlorocyclohexane (HCH), Chlorobenzilate, capatafol, dichlorodiphenyltrichloroethane (DDT), dieldrin, ethylence dibromide (EDB), methyl bromide, sodium cyanide, phenyl mercury acetate (PMA), lindane, methyl parathion and nicotine sulphate.

Pesticides comprise one of the major group of chemicals besides fertilizers, dyes, pharmaceutical and petrochemicals. Pesticides in particulars are special, though they are toxic but are introduced into the environment by man himself. The total picture of pesticides use in India does confirm that pesticides usage is low and unevenly scattered due to economic and other reasons. Every minute, someone is poisoned in the third world countries by pesticides. According to a United nation's report these highly toxic pesticides causes over two million poisoning annually and over 22000 deaths per year in India (Times of India 19.1.93). India accounts for one third of pesticides poisoning cases in the third world. In 1989, the World Health organization (WHO) estimated that pesticides poison three million people each year killing one in 14^{th} of them [6]. Farm labourers employed in the spraying operations, workers working in the pesticide manufacturing factories are worst affected.

At least 70% of the pesticides handled by the Indian farmer have been declared "excessively toxic" by world health organization. Unfortunately, pesticides are big money often banned in their country-of-origin stocks are dumped on eager to purchase developing nations. It is a known fact that one quarter of all pesticides exported by the United State are not registered for use in the US. They include cancelled or suspended pesticides because they may cause cancer or otherwise endanger human or the environment. The problems would further aggravate in the coming year, as many pesticides, particularly the chlorinated hydrocarbons directly affect the fetuses and neonates as they get transferred through placenta, cord blood, and mother milk respectively. This has been confirmed in all the mammalian species that have been examined including humans [7-15]. OCPs, such as Hexachlorocyclohexane (HCH) and DDT account for two-thirds of the total consumption in India [16] for agriculture and public health purposes respectively. Currently, there are about 165 pesticides registered for use in India, of which 40% are organochlorines [17].

The problems would further exacerbate in the coming year, as many pesticides mainly Organochlorines being lipophilic and non-biodegradable due to their great chemical solubility. Low aqueous solubility and high fat-soluble character became concentrated and magnified as they move up in the food chain [18]. Since man in at the top of the food chain he receives and accumulates insecticide residues that vegetables and animals have stored up in various periods of development [9,19] thus poisoning a challenge to the ecologists and toxicologists. It has been well established those pesticides, particularly the chlorinated hydrocarbons directly affect the fetuses and neonates as they get transferred through placenta and mother milk respectively. This has been confirmed in all the mammalian species that have been examined including humans [20].

The exposure of the general population to pesticide may occur through several environmental media, including cattle milk, food, water and air and to a lesser extent soil. There is evidence that greatest exposure to pesticides for the general population takes place as a result of ingesting milk, food and water containing small residues of pesticides. Some studies have already reported the occurrence and levels of OCPs in cattle milk from different countries, such as Romania, India, Mexico, and Colombia [21-23]. This type of incidental exposure of human beings may result in the accumulation of OCPs in their blood in quite high concentrations. Presence of pesticides in the blood and human milk is the indication of environmental pollution by these toxins or the body burden of these pesticides which in turn is a risk to the human health [9].

Cattle milk contamination with organochlorine pesticides can occur when these persistent chemicals are present in the environment and are ingested by the cows through contaminated feed, water, or exposure to contaminated pasture. Once ingested, these pesticides can accumulate in the fatty tissues of the animals, including their milk. Here are some key points related to cattle milk contamination with organochlorine pesticides:

1. **Feed and Forage Contamination:** Cows can be exposed to organochlorine pesticides by consuming contaminated feed or forage. Pesticides may persist in the soil and be taken up by plants, which are then consumed by the animals.
2. **Water Contamination:** If water sources used by cattle contain organochlorine pesticides, the contaminants may be ingested and accumulate in the animals' bodies, including the milk-producing glands.
3. **Bioaccumulation:** Organochlorine pesticides are known for their ability to bioaccumulate, meaning they build up in the fatty tissues of living organisms. As cows consume contaminated feed over time, the concentration of these pesticides in their bodies, and subsequently in their milk, can increase.
4. **Health Risks for Humans:** Consuming milk from cows that have been exposed to organochlorine pesticides poses potential health risks for humans. These pesticides have been associated with various health issues, including cancer, reproductive problems, and neurological disorders.
5. **Monitoring and Regulation:** Many countries have regulations in place to monitor pesticide residues in food products, including milk. Regular testing and monitoring programs help ensure that milk and other dairy products meet safety standards. Regulatory authorities may set maximum allowable limits for pesticide residues in food items to protect public health.
6. **Preventive Measures:** To minimize the risk of contamination, farmers can adopt sustainable agricultural practices, rotate pastures, and properly manage pesticide use.

Regular monitoring of feed, water, and the health of the herd can help identify and address potential issues.

Organochlorine pesticides have been associated with various health issues in humans, including cancer, reproductive disorders, and neurological problems. Exposure can occur through contaminated cattle milk, food, water, and air. Recognizing the environmental and health risks, many countries have implemented regulations and restrictions on the use of OCPs. Some of these pesticides have been banned, and others are subject to strict controls. There are many reports from India and all over the world giving an idea about the concentration of detectable OCPs in the cattle milk but no such report is available from Alwar, NCR of Delhi of India, Jaipur. A monitoring study was, therefore, was planned and conducted in Alwar, National capital Territory of Delhi to assess the OCPs residues in the cattle milk using gas liquid chromatography. The results revealed the presence of isomers of HCH, heptachlor, DDT, Endrin, Endosulphan, Chlordane and its metabolites and Methoxychlor, Dieldrin, Aldrin in the milk samples analyzed. This is the very first report from Alwar, India on the cattle milk contamination of the OCPs residues indicating the pesticide pollution by these xenobiotics, which in turn is a risk to human health and environment as a whole. Secondly, this may be considered as an indication of the transfer of these chemicals from environment to flora and fauna including human and then bioconcentration and bioaccumulation processes may lead to detrimental effects.

We here report the results of the chemical analysis of 50 Cattle milk samples for isomers of HCH, heptachlor, DDT, Endrin, Endosulphan, Chlordane and its metabolites and Methoxychlor, Dieldrin, Aldrin from Alwarby using very sensitive and well controlled chemical analysis technique Gas Liquid Chromatography (GLC). The results are further stratified in the form of table and histogram.

MATERIALS AND METHODS

Study area

Site selected for the monitoring study is Alwar, NCR of Delhi. Alwar city is a part of Alwar district in India, located in a state of Rajasthan, in the north eastern part of Rajasthan and extends between north latitude 27°03’ and 28°14’ and east longitude 76°07’ and 77°13’. It covers 8720 sq. km of geographical area. Climate of the district can be classified as semi-arid. The district occupies about 2.45% of total area of the State. Climate of the Alwar is classified as semi-arid. Weather is very hot in summer and very cold winters with fairly good rainfall during south west monsoon period. In May and June, the maximum temperature may go up to 47°C.Normal annual rainfall of the district is 631mm. There is no river is flowing throughout the year. The seasonal rivers, which flow through the district and carry the runoff from the hills are Landoha, Ruparail (Barah), Chuhar Sidh and Sabi (Sahibi) [24]. Alwar has extensive sites around the city and principal crops of Alwar are bajra, jowar, wheat, maize, pulses, oilseed. irrigation by different sources like tubewell, dug well, can etc. The most important water body is Siliserh lake which is an artificial lake constructed by Maharaja Vinay Singh in 1845. The purpose of building the lake was to provide a water reservoir to the residents of Alwar and to address the water scarcity issues in the region. Siliserh Lake is surrounded by hills and forests, adding to its natural beauty. Rural side of the city has good cattle population around the city as grazing landscapes give animals readily availability of the fodder.

Sampling

Fifty samples of each dairy (toned and whole) and buffalo milk were collected at random from Alwar, NCR of Delhi, Rajasthan, India, during September 2023 to January 2024. Buffalo milk samples (fat content is 7.8%) were collected from vendors, and toned (fat content is 3%) and whole milk (fat content is 5%) samples were collected from Saras dairy that supplies dairy milk to Alwar. After collection, all the samples were stored at 4°C until the extraction was done.

Extraction and Cleanup of Pesticide from Samples

Extraction of organochlorine pesticide residues of isomers of HCH, heptachlor, DDT, Endrin, Endosulphan, Chlordane and its metabolites and Methoxychlor, Dieldrin, Aldrin from the milk samples were done within 2 days of collection. Prior to the extraction, all the glassware were properly washed with soap and water followed by distilled water, and finally rinsed with acetone and heated at 200± 220°C in an oven to avoid any contamination of pesticides. Extraction and cleanup of the collected samples were done using the method suggested by Takie et al. (1983) [25] with modification. The first extraction was done with the mixture of acetone (4 ml), acetonitrile (2 ml), and hexane (15 ml). Second extraction was done with acetone (2 ml), acetonitrile (2 ml), and hexane (10 ml). The solvent layer was washed with acetonitrile (3 ml), 2% Na2SO4 (3 ml), and hexane (3 ml). Cleanup was done using a glass column packed with florisil (5 g) and Na2SO4 anhydrous (5 g). The column was eluted with hexane (15 ml) and 1% methanol in hexane (10 ml). The final extracts, after cleanup, were evaporated to dryness using rotatory vacuum evaporator. The dried extract was dissolved in 2 ml hexane for Gas Chromatograph analysis.

Quantitative Estimation

Quantitative estimation of pesticide residues in all the extracts was done by GC model Agilent 8890, equipped with Electron Capture Detector (ECD) Ni63 device regulatory model no-G2397A. Capillary Column used was Agilent J & W GC Column (DB-CLP1). The Purified nitrogen (IOLAR-1) was used as a carrier gas at the flow rate of 65 ml per min. Temperature in the GC maintained as follows: Injector temperature: 250 ◦C, Column temperature: 275 ◦C and Detector temperature: 340 ◦C. One micro litre of aliquot was injected in the column with the help of the 10 µl Hamilton syringe. Different peaks of the samples were identified by comparing their retention times with those of standards. Quantitation of the samples were done by the data obtained from the chromatogram on the computer system attached with GC and were based on peak areas. Standards were obtained from Environmental Protection agency (EPA) U.S.A.

Recovery Analysis and Confirmation of Pesticide residues

Recovery analysis was done by fortification experiments and the percentage recovery was 95–98%. The pesticides for which the GC was standardized and were estimated are isomers of HCH, heptachlor, DDT, Endrin, Endosulphan, Chlordane and its metabolites and Methoxychlor, Dieldrin, Aldrin. Thin Layer Chromatography (TLC) was used for confirming the identity of the OCPs already detected by the GC according to the modified method of Thompson et al. (1970) [26].

Statistical Analysis

The calculations are based on biological statistics and values are expressed as mean± standard error (S.E.). The difference in the pesticide residue levels between different groups was analyzed with the help of student t test. Significance between the residue levels of different groups was judged at 5 % and 1% levels.

OBSERVATIONS AND RESULTS

The amount of OCPs detected in the 50 cattle milk samples from Alwar are presented in the form of tables and graphs.

3 Concentration of OCPs in the 50 cattle milk Samples from Alwar (ppb) are shown in the Table.1.

4 Graphical representation of data is shown in figure 1&2.

3 High concentrations of OCPs were found in all the cattle milk samples analyzed for isomers of HCH, heptachlor, DDT, Endrin, Endosulphan, Chlordane and its metabolites and Methoxychlor, Dieldrin, Aldrin

5 Sample Chromatogram

Table.1: Concentration of OCPs in the 50 Cattle Milk Samples from Alwar (ppb).

S. No	Organochlorine pesticides detected	samples(N)	Range	Mean±S.E	p
1.	α BHC	50	0.017-0.499	0.108±0.017 (n=45)	< .001
2.	γ BHC	50	0.018-0.650	0.152±0.025 (n=45)	< .001
3.	βBHC	50	0.038-0.834	0.213±0.033 (n=42)	< .001
4.	Heptachlor	50	0.009-0.665	0.167±0.021 (n=43)	< .001
5.	δ BHC	50	0.046-0.870	0.125±0.020 (n=45)	< .001
6.	Aldrin	50	0.013-0.272	0.060±0.009 (n=40)	< .001
7.	Heptachlor Epoxide	50	0.003-1.246	0.230±0.042 (n=41)	< .001
8.	γ Clordane	50	0.011-0.713	0.230±0.025 n=(45)	< .001
9.	α Clordane	50	0.017-0.478	0.142±0.017 n=(43)	< .001

10.	Endosulfan 1	50	0.0023-0.473	0.087±0.016 n=(35)	< .001
11.	4,4-DDE	50	0.01-0.473	0.103±0.016 n=(43)	< .001
12.	Dieldrin	50	0.02-0.452	0.091±0.013 n=(41)	< .001
13.	Endrin	50	0.034-0.938	0.143±0.027 n=(32)	< .001
14.	4,4-DDD	50	0.02-0.788	0.186±0.027 n=(37)	< .001
15.	Endosulfan II	50	0.01-0.679	0.164±0.018 n=(47)	< .001
16.	4,4-DDT	50	0.014-0.470	0.137±0.016 n=(44)	< .001
17.	Endrin Aldehyde	50	0.085-0.644	0.232±0.022 n=(46)	< .001
18.	Endosulfan Sulphate	50	0.079-0.605	0.200±0.019 n=(47)	< .001
19.	Methoxychlor	50	0.045-1.687	0.219±0.047 n=(45)	< .001
20.	Endrin Ketone	50	0.074-0.605	0.188±0.023 n=(43)	< .001
21.	∑DDT	50	0.044-1.731	0.427±0.042 n=(41)	< .001
22.	∑BHC	50	0.017-2.093	0.558±0.070 n=(45)	< .001
23.	∑ Clordane	50	0.02-1.145	0.372±0.037 n=(44)	< .001
24.	∑Endosulfan	50	0.19-1.506	0.254±0.030 n=(41)	< .001
25.	∑Endrin	50	0.131-2.183	0.563±0.060 n=(50)	< .001
26.	∑Heptachlor	50	0.012-1.690	0.397±0.046 n=(50)	< .001
27.	∑OCPs	50	0.866-9.577	3.178±0.277 n=(50)	< .001

∑DDT=4,4-DDE+4,4-DDD +4,4-DDT
∑BHC= α- BHC + γ- BHC + β- BHC + δ- BHC
∑Clordane= γ- Clordane+ α- Clordane
∑Endosulfan= Endosulfan Sulphate+ Endosulfan I + Endosulfan II
∑Endrin= Endrin+ Endrin Ketone + Endrin Aldehyde
∑Heptachlor= heptachlor+ Heptachlor Epoxide
∑OCPs= α- BHC + γ- BHC + β- BHC + δ- BHC+ γ- Clordane+ α- Clordane+ Endrin+ Endrin Ketone + Endrin Aldehyde+ Aldrin + Dieldrin+ heptachlor+ Heptachlor Epoxide+ Endosulfan Sulphate+ Endosulfan I + Endosulfan II+ Methoxychlor+4,4-DDE+4,4-DDD +4,4-DDT
S.E.-Standard Error
P-Statistically Significant
n-no of positive samples
ND-not detected
N-No of samples

Figure: 1. Mean Concentrations of OCPs detected in the 50 Cattle Milk Samples from Alwar (ppb).

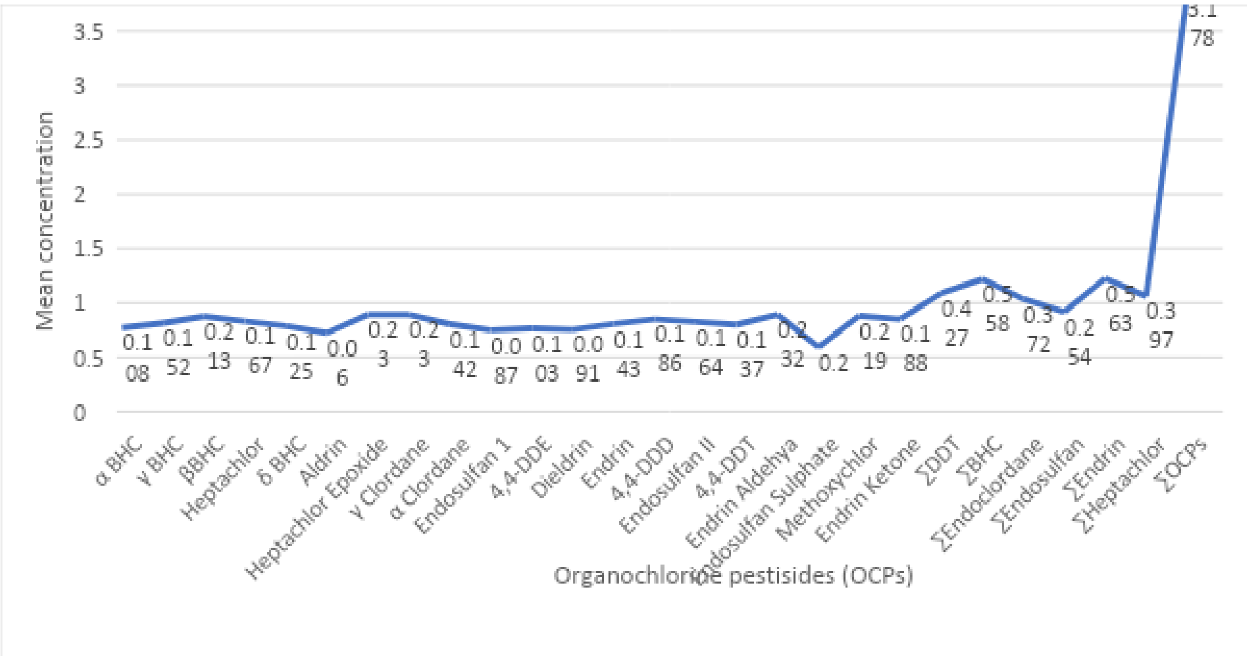
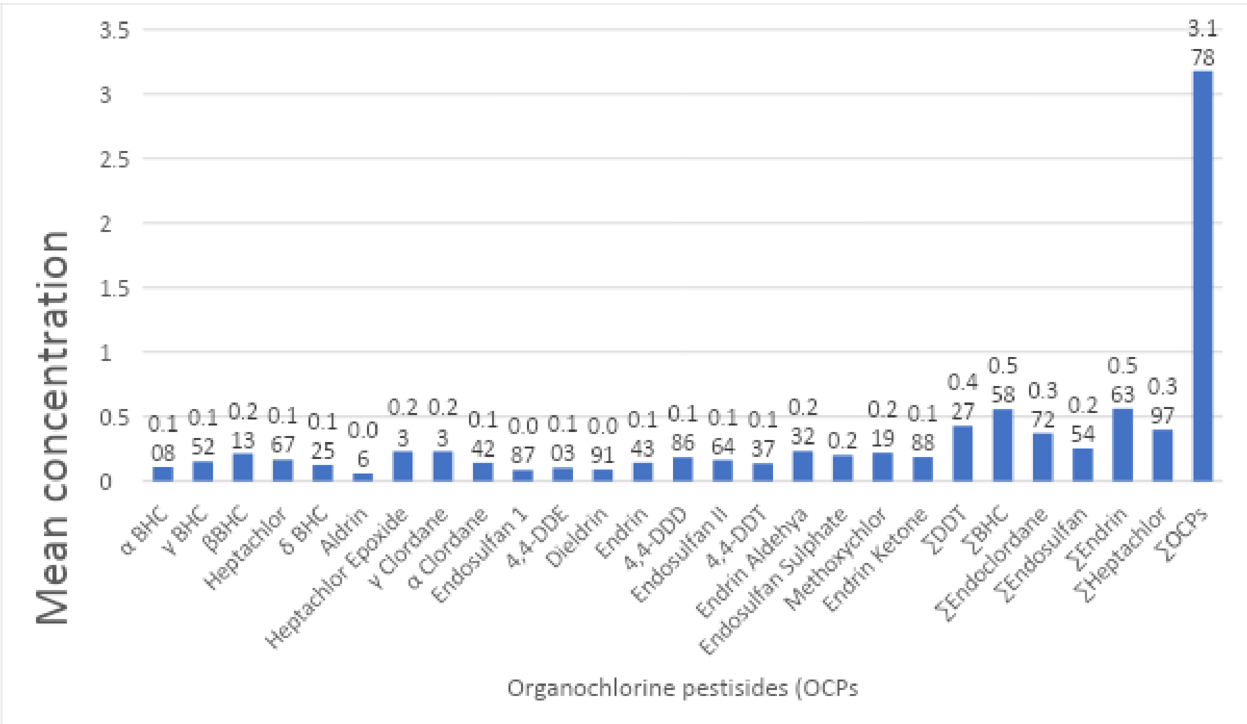


Figure: 2. Mean Concentrations of OCPs detected in the 50 Cattle Milk Samples from Alwar (ppb).

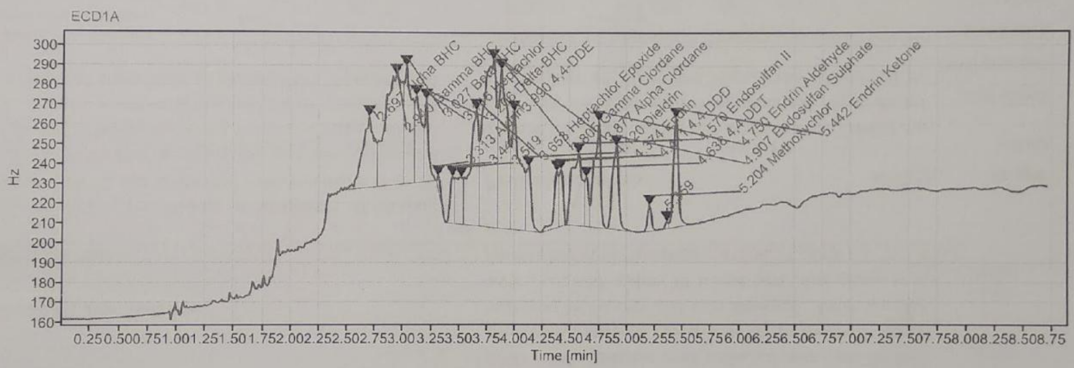


ISSN: 2347-6532 Impact Factor: 6.660

6 Chromatogram of Cattle milk sample.

Single Injection Report — Agilent

Sample name:	Gulshan sample 8		
Data file:	Gulshan sample 8.dx	**Operator:**	SYSTEM (SYSTEM)
Instrument:	GC	**Injection date:**	2023-10-06 04:11:15+05:30
Inj. volume:	1.000	**Location:**	
Acq. method:	pesticide method.amx	**Type:**	Sample
Processing method:	Chlorinated pesticide processed.pmx	**Calib Level:**	
		Sample amount:	0.00
Manually modified:	None		



Signal: ECD1A

Name	RT [min]	RF	Area	Amount []	Concentration []	Group
Alpha BHC	2.70	1234.356	267.062	0.216	0.216	
Gamma BHC	2.94	1196.860	605.309	0.506	0.506	
Beta BHC	3.03	589.953	281.529	0.477	0.477	
Heptachlor	3.12	883.774	180.818	0.205	0.205	
Delta-BHC	3.21	1237.979	98.817	0.080	0.080	
Aldrin	3.31	1337.627	17.445	0.013	0.013	
Heptachlor Epoxide	3.65	1133.774	333.518	0.294	0.294	
Gamma Clordane	3.80	1216.419	693.616	0.570	0.570	
Alpha Clordane	3.88	1161.874	440.799	0.379	0.379	
4,4-DDE	3.99	1267.553	333.673	0.263	0.263	
Dieldrin	4.12	955.652	108.157	0.113	0.113	
Endrin	4.37	749.770	86.934	0.116	0.116	
4,4-DDD	4.41	654.332	72.447	0.111	0.111	
Endosulfan II	4.57	1014.882	248.397	0.245	0.245	
4,4-DDT	4.64	874.036	61.000	0.070	0.070	
Endrin Aldehyde	4.75	691.231	223.762	0.324	0.324	
Endosulfan Sulphate	4.91	933.866	178.321	0.191	0.191	
Methoxychlor	5.20	245.126	32.535	0.133	0.133	

C:\CDSProjects\2023\Oct\Report Templates\Short_Estd.rdl [Rev. 1] Printed: 2023-10-06 04:25:42+05:30 Page 1 of 2

DISCUSSION

In this study we report, High concentrations of OCPs were found in all the cattle milk samples analyzed for isomers of HCH, heptachlor, DDT, Endrin, Endosulphan, Chlordane and its metabolites and Methoxychlor, Dieldrin, Aldrin from Alwar. The observations shows that concentration values of different OCPs is either touching the permissible limits or higher than the permissible limits. Many of the OCPs have been banned in India like DDT for agriculture use but they are available in the common market for public health purposes [27]. But many others are still available and approved in India being the third world country. The use of pesticides was commended in India during 1948-49, but the country actually witnessed a tremendous increase in pesticides consumption with the onset of “green revolution” India, today uses around 75 MT of technical grade pesticides to cover 182.5 million hectares of cultivated land. The present demand for technical grade pesticides may go up to 144000 MT by the end of century [5]. Over 46 technical grade pesticides are produced indigenously, including insecticides (19), fungicides (7), rodenticides (1), weedicides and plant growth regulates (9), fumigants (4) and antibiotics (2). in India per hectare pesticides consumption is quite low ranging between 250 and 400 g/ha compared to developed countries such as a USA (1150 g/ha), West Germany (2000 g/ha) and Japan (11000 g/ha) [28] India is the largest producer and consume of pesticides in south Asia, and pesticides use has been on rise in the last three decades, Andhra Pradesh is the largest user in the country followed by Tamil Nadu and Uttar Pradesh. The hectare use of the plant protection chemicals is highest in Tamil Nadu, which is far ahead of the second and third major User, Punjab and Andhra Pradesh [29]. A variety of chemicals of extremely different composition and properties have been used as pesticides. They range from simple inorganic compound such as lead arsenate and copper sulphate to complex mixtures of organic molecules, like organochlorines, organophosphates, carbamates and polychlorinated biphenyls. Many of these pesticides are broad spectrum biocides, few of them are very toxic to a particular group of animals and most of them are relatively innocuous to nearly all organism. The potential danger Lies with the compounds that are non-biodegradable and persistent, thus indicating their capacity to accumulate in the biological system and becoming slow agents of toxicity. Pesticides, human health and safety of the environmental have been a global concern. Public attention was first focused on the detrimental effects of pesticides use following the 1956 publication of Spector’s book “Hand book toxicology” which greatly magnifies the potential hazard of persistent of genetic biologist Dr. Rachel Carson's bool “Silent Spring” Which showed how pesticides had entered the food chain of birds in United State. Hygiene and Public Health, Calcutta, and The Central Plant Protection Training Institute, Hyderabad, Have shown that in India, per hectare consumption of pesticides is quite low in comparison of many developed countries even than our daily food intake is laced with some of the highest amounts of toxic pesticides residues found in world i.e. in India our daily diet contains 0.27 mg DDT [1].Here, it may note that the maximum safe limit of DDT in the daily diet of a person is five microgram per kg body weight that would amount to about 0.3 mg of DDT in the daily diet of an average person, meaning we Indian are touching and often surpassing the upper limit of DDT intake (2) An Indian ingests 40 times more pesticides with his food than the average American or Englishman. The level in the body fat of the residents of Delhi, for instance found to 26 ppm on an average, the highest in the world, far exceeding the maximum residue limit of 1.25 ppm (Hindustan Times, 3.11.90) Rural population however, face an increased risk of exposure due to characteristic occupational activities like exposure on farms, and non-point sources of environmental contamination (e.g. by consuming contaminated cattle milk, food or drinking water). Moreover, the abysmally low levels of literacy and health unconsciousness along the country side further magnifies the risk factor.

Efforts to mitigate these consequences involve monitoring and regulation of pesticide use, adoption of sustainable agricultural practices, and ensuring proper disposal of obsolete pesticides. Regular testing of milk and other food products for pesticide residues is crucial for ensuring food safety and protecting both animal and human health. If OCP contamination is confirmed, measures should be taken to identify and eliminate the sources of contamination to prevent further exposure.

There are many ways that how OCPs reach cattle animals and finally excreted through their milk:

1) Through Contaminated Feed:

a. Cattle can be exposed to OCPs by consuming feed that is grown in soil contaminated with these pesticides. The pesticides may be present in the soil due to historical or current agricultural practices.

2) Contaminated Water Sources:

a. Water sources used by cattle may be contaminated with OCPs from runoff or direct application. This can happen if water bodies receive runoff from fields where OCPs have been used, or if the water itself is contaminated.

3) Inhalation and Skin Contact:

a. Cattle can also be exposed to OCPs through inhalation and skin contact. Pesticides applied to crops or present in the environment may be absorbed by the animals during grazing or through direct contact with contaminated surfaces.

4) Airborne Transport:

a. OCPs can be transported over long distances through the air. Cattle may be exposed to these pesticides through the inhalation of contaminated air or through the deposition of pesticides onto their fur and skin.

Organochlorine pesticides (OCPs) found in cattle milk samples can have various consequences, both for the cattle and potentially for humans consuming the contaminated milk. Here are some of the key consequences:

1) Health Impact on Cattle:

a. OCPs, particularly those with long persistence in the environment, can have toxic effects on cattle. Prolonged exposure may lead to health issues such as reproductive disorders, immune system suppression, and disruptions in metabolic processes.

2) Milk Quality and Composition:

a. Contamination of Milk: OCPs, being lipophilic, tend to accumulate in fatty tissues. This accumulation can result in the presence of these pesticides in the milk fat. Contaminated milk may have lower quality and pose risks to consumers.

3) Bioaccumulation:

a. Higher Trophic Levels: As cattle consume contaminated feed, water, or forage, OCPs can accumulate in their bodies. This bioaccumulation is especially significant in animals at higher trophic levels in the food chain.

4) Human Health Concerns:

a. Transfer to Humans: Humans who consume milk or dairy products from cattle exposed to OCPs may face health risks. OCPs have been associated with various health issues in humans, including cancer, reproductive disorders, and neurological effects.

5) Environmental Impact:

a. Runoff and Soil Contamination: The use of OCPs in agriculture can lead to runoff, resulting in the contamination of soil and water sources. This contamination can persist in the environment, affecting other plants, animals, and ecosystems.

OCPs are characterized by their resistance to degradation, meaning they persist in the environment for extended periods. This persistence can lead to long-term contamination of soil, water, and sediments. tend to accumulate in the fatty tissues of living organisms. As they move up the food chain, from lower to higher trophic levels, the concentration of OCPs increases, posing a risk to predators at the top of the food chain, the process called as bioaccumulation. Following are notorious properties of OCPs. Resulting in the excretion in the cattle milk:

1. Persistence in the Environment:

- Organochlorine pesticides are known for their environmental persistence, meaning they can remain in soil, water, and sediment for extended periods. This persistence contributes to their bioaccumulation in the food chain.

2. Common Organochlorine Pesticides:

- DDT (dichlorodiphenyltrichloroethane): Although its use has been largely phased out in many countries, DDT can still be found in some regions due to its historical use.
- Dieldrin and Aldrin: These pesticides were once widely used for controlling soil-dwelling pests.
- Chlordane: Used for termite control and as an insecticide.
- Endosulfan: While not strictly an organochlorine, endosulfan is a chlorinated pesticide that has been widely used in agriculture.

3. Potential Routes of Exposure:

- Cattle can be exposed to organochlorine pesticides through ingestion of contaminated feed, water, and soil. The pesticides may also be absorbed through the skin during grazing or through inhalation**.**

4. Milk Composition:

- Organochlorine pesticides have a lipophilic (fat-loving) nature, which means they tend to accumulate in fatty tissues. Since milk contains fat, these pesticides can concentrate in the milk, particularly in the milk fat.

5. Human Health Concerns:

- Chronic exposure to organochlorine pesticides through contaminated milk may pose health risks to humans. These risks include potential carcinogenic effects, reproductive issues, and neurological disorders.

6. Global Regulations:

- The Stockholm Convention on Persistent Organic Pollutants, an international treaty adopted in 2001, aims to eliminate or restrict the production and use of persistent organic pollutants, including certain organochlorine pesticides. Many countries have implemented measures to comply with this convention.

7. Monitoring Programs:

- Various countries have monitoring programs in place to regularly test and assess pesticide residues in food products, including milk. This helps ensure compliance with safety standards and regulations.

8. Alternative Pest Control Methods:

- Encouraging the adoption of integrated pest management (IPM) practices and alternative, less persistent pesticides can help reduce the reliance on organochlorine pesticides in agriculture.

9. Educational and Public Awareness Initiatives:

- Public awareness and education campaigns play a crucial role in informing farmers and consumers about the risks associated with organochlorine pesticides and promoting sustainable agricultural practices.

Pesticides are carried in rainwater runoff from farm fields, sub urban lawns or roadside embankments into the nearest creeks streams and rivers. Occasionally they are even calculatedly sprayed into waterways as part of a pest-control effort. Commonly used pesticides can be harmful to environment and living organisms as they enter into creeks streams and river water, air and soil. Pesticides enter surface and ground water primarily as runoff from crops and are most prevalent in agricultural areas. Pesticides are also used on golf courses, forested areas, along roadsides, and in suburban and urban landscape areas.

The main use of pesticides in the country is in agriculture, food storage and public health sections to combat pests and diseases which effect men. Cosmetic pesticides are also sprayed wantonly on fruits and vegetables in major cities to improve the “look”, methyl parathion on cauliflower gives an extra white look, Bhindi is dipped in copper sulphate to look greener. Out of 123 chemicals, pesticides allowed in India, DDT, IICCI(BHC) and malathion are used in public health programmes. In India, unlike in many developed countries, organochlorine pesticides especially DDT and HCH constitute the 2/3 of the total pesticides consumption because these are ten times cheaper than most other pesticides, easy to handle and attack a wide range of pests [3] As a result, today food grain such as wheat and rice as well as vegetables and fruits contain varying number of pesticides residues. The latter often becomes an integral part of the food stuff, which means they cannot be removed completely by washing or cooking.

There are several factors which influence a pesticides’ potential to contaminate water. The ability of the pesticide to dissolve in water (solubility). Environmental factors, such as, soil, weather, season, and distance to water sources. Application methods and other practices associated with the pesticide use. Groundwater contamination is higher when there is no crop or a young crop. A large actively growing crop has the ability to reduce pesticide concentration through a variety of mechanisms. Larger plants consume more water from the soil and therefore reduce the ability of a pesticide to migrate through the soil and enter streams or groundwater. Larger plants can collect precipitation which prevents pooling of water and run-off from the area. Root zones enrich the microbial community of the soil which then enhances the biodegradation of the pesticide by bacteria. Pesticides are those chemicals (such as insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, plant growth etc.), which have been widely used throughout the world to increase crop yield and to kill the insect-pests responsible for transmitting various diseases to humans and animals. However, according to several reports, these chemicals have been proved to inflict adverse impacts on the health of living beings and their environment. [30]. Pesticide impacts on aquatic systems are often studied using a hydrology transport model to study movement and fate of chemicals in rivers and streams.

Furthermore, startling studies have indicated that we have largely over looked the darker side of these chemicals as OCPs are reported to be carcinogenic [31], [32] mutagenic [32],[33] teratogenic [33],[34] immunosuppressive [35],[36] create endocrine dysfunction such as hypothyroidism or high estrogenic activity [37],[38] disturb reproductive processes [39],[40] growth depressants [41],[42] induces several psychogenic and neurogenic abnormalities in adult stages [43],[44], diabetes [45], obesity [46], respiratory diseases [47]and are associated with abortions, premature deliveries, still births and infants with low birth weights [48]-[50], OCPs have been in use in India nearly for a half century now. Even after having clear cut evidence suggesting that these chemicals have the ability to eliminate entire species from the planet, the annual consumption of pesticides in India is about 85,000 tons of which OCPs comprise the bulk [51]. Therefore, today OCPs are perhaps the most ubiquitous of the potentially harmful chemicals encountered in the environment and are still widely detected in humans despite the considerable decline in environmental concentrations [52].

CONCLUSION

It is quite clear from the foregoing discussion The widespread application of pesticides in healthcare and agriculture, coupled with a lack of focus on environmental concerns, has led to their presence in surface water, soil, and the atmosphere. Consequently, these pesticides infiltrate the food chain, exerting a significant influence on agricultural ecosystems, groundwater, gardens, and agricultural produce and cattle milk. [53,54]. This is because in the third world countries such as India, because of the cost - benefit ratio OCPs are still the major pesticides used in agriculture and public health sector. This is in accordance with the findings of Dale and his coworkers (1965) that the Indians have got the highest body burden of OCPs [55].

The present study directly reflects the national scene of magnitude of pesticide pollution in cattle milk. It can be concluded that the magnitude of pesticide pollution is quite high to contaminate the food and environment and as a result, toxicant reach the human body through various sources mainly through the absorption from the gastrointestinal tract via contaminated food chain like cattle milk and causing the exposure to flora and fauna including humans [56-60]. Since, the pesticides are reported to be carcinogenic, mutagenic, teratogenic, immunosuppressive, induces endocrine dysfunction and high estrogenic activity, respiratory diseases, diabetes, obesity, 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, still births, low birth weight consequences are obvious on the biodiversity and humans. Present findings on environmental toxicology of pesticides particularly in relation to distribution of pesticide pollutants in the cattle milk may finally lead to a better understanding of the influence of chemicals on our mother nature and provide grounds for further studies on pesticide pollution in India. In the end, it must be emphasized that there is a rising protest that pesticides are destroying harmless wild life and endangering the health of man himself. The battle against the harmful insects would be much less costly and more efficient, and the problem of contamination of the environment by toxic materials would be vastly reduced, if insect activities are controlled by natural means. The use of pest-specific predators; parasites or pathogens; sterilization of insects with the help of radiations; trapping insects using insect attractants like pheromones; use of juvenile hormones or hormone inhibitors may therefore be suggested as alternate ways of pest control. chemical pesticides will continue to perform a vital role in pest management. We need to phasing out the chemical pesticide and replace with bio-pesticide. Constant monitoring of cattle milk should undergo advanced water treatment. Regular monitoring and testing of milk for pesticide residues are crucial to ensuring food safety and compliance with regulatory standards. Encouraging farmers to adopt alternative, less persistent pest control methods and integrated pest management practices can help reduce the reliance on OCPs.

ACKNOWLEDGEMENTS

Financial Assistance provided by PMUSA is gratefully acknowledged.

REFERENCES

1. Chapgar B.F. (1993): Oil and Water do not mix. In:THE HINDU.Survey of the Environment. Ed: N. Ravi, National Press, Madras. India.

2. Bhatt, P.K.(1988): Pesticides: Do we have their alternative. In: Junior Science Refresher.February issue.

3. Chengappa, R. and Rajghatta, C. (1989): Poison in your food. In: India Today, June.15, 74-83.

4. Defense Lojestis Agency (1981): Environmental impact statement: Transportation and final disposal of U.S. Department of Defense stocks of DDT. DAKA. 4580-0032. Battle Creek. Ml.

5. Gupta, P.K. (1986): Pesticides in the Indian environment (Eds. Bhatia, B. and Varshney, C.K. Interprint Publishers, New Delhi; India.

6. Charles, D, (1991): California's war on pesticides. New Scientist, 2nd March.
7. Zhang, X., Wu, X., Lei, B., Jing, Y., Zhang, X., Fang, X., & Yu, Y. (2018). Transplacental transfer characteristics of organochlorine pesticides in paired maternal and cord sera, and placentas and possible influencing factors. Environmental Pollution, 233, 446-454.
8. Sharma, M., & Bhatnagar, P. (1996). Organochlorine pesticides and preterm labour in human beings. Current Science, 628-631.
9. Sharma. M. (1996). Transplacental movement of pesticides in women from Jaipur. Ph.D. thesis submitted to department of Zoology, University of Rajasthan, Jaipur, Rajasthan, India.
10. Sharma, M. (2021 a). Pesticide Residues in Drinking Water and Cattle Milk. High Time to find an alternative to Chlorinated Hydrocarbons" in a journal of Innovative Research in Clinical and Medical Sciences (JIRCMS), Vol-5, Issue-1, 1-6.
11. Sharma, M. (2021b) Organochlorine Pesticides in Cord Blood: A Threat to the Safety of Prenates. Journal of Innovative Research in Clinical & Medical Sciences. Vol.4, (4), 6-16.
12. Sharma, M. (2021c) Organochlorine Pesticides in Human Placenta: A Threat for Prenates. Journal of Innovative Research in Clinical & Medical Sciences. Vol.05, (2) ,1-11.
13. Sharma, M. (2021d) Organochlorine Pesticides in Human Milk: A Source of toxicants for Neonates, research article for a book on science and technology entitled "Emerging Trends in Science and Technology" Edited by Dr. M.K. Kumawat & Dr. N. Singh. IISN No-978-81-951982-2-1 by Bhumi Publishing, Nigave Khalasa, Kolhapur 416207, Maharashtra, India, 2021.
14. Sharma, M. & Bhatnagar, P. (2017). Pesticide burden in women from Jaipur in relation to ethnicity, religion and addiction habit. International Journal of Environmental Science and Development, Vol. 8, No. 3, 216-220.
15. Sharma, M and Singh. (2021). Organochlorine Pesticides in Human Milk: A Recap." in an International Journal of Current Trends in Engineering & Technology-IJCTET Vol-7, Issue-3, 29-41.
16. Kumari A, Sinha RK, Gopal K, Prasad K (2001) Dietary intake of persistent organochlorine residues through Gangetic fishes in India. Int J Ecol Environ Sci 27:117–120.
17. Siddiqui, M. K. J. (1982). Biochemical studies on tissues accumulating pesticides (Doctoral dissertation, Ph. D. Thesis submitted to the University of Lucknow, India).
18. Zhang, X., Wu, X., Lei, B., Jing, Y., Zhang, X., Fang, X., & Yu, Y. (2018). Transplacental transfer characteristics of organochlorine pesticides in paired maternal and cord sera, and placentas and possible influencing factors. Environmental Pollution, 233, 446-454.
19. Mathur, V., Bhatnagar, P., Sharma, R. G., Acharya, V., & Sexana, R. (2002):Breast cancer incidence and exposure to pesticides among women originating from Jaipur. Environment international, 28(5), 331-336.
20. 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

21. Miclean, M., Levei, E. A., & Cadar, O. (2024). Organochlorine Pesticides in Dairy Cows' Diet and the Carryover into Milk in NW Romania. *Sustainability*, *16*(1), 434.
22. Rai, S., & Bajpai, S. P. (2017). A Review on Levels of Organochlorine Pesticides in Animal Milk. *Int. J. Sci. Dev. Res*, *2*(4), 647-651.
23. John, P. J., Bakore, N., & Bhatnagar, P. (2001). Assessment of organochlorine pesticide residue levels in dairy milk and buffalo milk from Jaipur City, Rajasthan, India. *Environment International*, *26*(4), 231-236.
24. https://cgwb.gov.in/old_website/District_Profile/Rajasthan/Alwar.pdf
25. Takie GH, Kauahikaua SM, Leong GH. Analysis of human milk samples collected in Hawaii for residues of organochlorine pesticides and polychlorobiphenyls. Bull Environ Contam Toxicol 1983;30:606 ± 13
26. Thompson, R. H., Hill, E. G. and Fishwick, F. B.: 1970, 'Pesticide residues in Britain XIII. Organochlorine residues in cereals, pulses and nuts', Pestic. Sci. 1, 93–98
27. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1896140
28. Bami, H.L.(1992): Pesticides risks - An overview of Indian Scene. pesticide information, Oct - Dec.
29. Venkataramani, G. (1992): Pesticides. Harm far outweighs use. In: The Hindu, Survey of the environment. Ed: N.Ravi, National Press. Madras, India. pp 12935.
30. Igbedioh, S. O. (1991). Effects of Agricultural Pesticides on Humans, Animals and Higher Plants in Developing Countries. Archives of Environmental Health, 46(4), 218–223. doi:10.1080/00039896.199 1.9937452 PMID:2069430
31. Mathur, V., Bhatnagar, P., Sharma, R. G., Acharya, V., & Sexana, R. (2002):Breast cancer incidence and exposure to pesticides among women originating from Jaipur. Environment international, 28(5), 331-336.
32. 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.
33. 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.
34. 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.
35. 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.
36. 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.
37. 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.
38. 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.
39. 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.

40. Tiemann.U. (2008): In vivo and in vitro affects 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.

41. 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.

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

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

44. 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.

45. Evangelou, E., Ntritsos, G., Chondrogiorgi, M., Kavvoura, F. K., Hernández, A. F., Ntzani, E. E., & Tzoulaki, I. (2016). Exposure to pesticides and diabetes: A systematic review and meta-analysis. *Environment international*, *91*, 60-68.

46. Lee, D. H., Porta, M., Jacobs Jr, D. R., & Vandenberg, L. N. (2014). Chlorinated persistent organic pollutants, obesity, and type 2 diabetes. *Endocrine reviews*, *35*(4), 557-601.

47. Tual, S., Clin, B., Levêque-Morlais, N., Raherison, C., Baldi, I., & Lebailly, P. (2013). Agricultural exposures and chronic bronchitis: findings from the AGRICAN (AGRIculture and CANcer) cohort. *Annals of Epidemiology*, *23*(9), 539-545.

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

49. 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

50. 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.

51. 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.

52. India Environment Portal Knowledge for change, 30/10/1998.

53. 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.

54. 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

55. Dale. W.E., Copeland, M.F., Hyes, W.J. (1965): Chlorinated insecticide in the body fat of people in India. Bull. World. Hith. org. 33,471 - 77.

56. Rathore. P, Sharma. M, Chhangani. A.K.(2021). Locust Outbreak and Its Management in Thar Desert, Rajasthan. International Journal of Engineering & Scientific Research Vol.09 Issue 01, January.

57. Swami. D, Sharma. M, Chhangani. A.K. (2021). Present Status of Traditional Rainwater Harvesting Structures in and Around Bikaner City, Rajasthan International Journal of Engineering & Scientific Research Vol.09 Issue 02, February.

58. Ojha. P, Sharma. M, Imran, Rajpurohit L. S. and Chhangani. A.K. (2020).
Survival of Mammalian diversity in and around Human Landscape, in the Thar Desert, Rajasthan. International Research Journal of Natural and Applied Sciences. Volume 7, Issue 11, November.

59. Sahel. H, Sharma. M, Chhangani. A.K. (2020). GIS Mapping of Municipal Solid Waste Sources, Transportation Routes and Disposal in Bikaner City, Rajasthan, India. International Research Journal of Natural and Applied Sciences. Volume 7, Issue 01, January.

60. Jangeed. P, Sharma. M, Chhangani. A.K. (2020). Present Scenario of House Sparrow Breeding in Human Landscape in Thar Desert, Bikaner, Rajasthan. International Research Journal of Natural and Applied Sciences, Volume 7, Issue 6, June.