SUMMARY
ON
PESTICIDE RESIDUES IN BOVINE AND HUMAN MILK IN DHANBAD CITY, DHANBAD, JHARKHAND

BY
RITUPARNA MITRA BARMAN

THESIS SUBMITTED
IN THE PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY

OF
DEPARTMENT OF RURAL DEVELOPMENT AND AGRICULTURAL PRODUCTION
SCHOOL OF HUMAN AND ENVIRONMENTAL SCIENCES
NORTH – EASTERN HILL UNIVERSITY
TURA CAMPUS, TURA – 794002, MEGHALAYA
DECEMBER 2015
ABSTRACT

Pesticides are substances used for the control of insects, fungus, weeds, rodents and other pests which are harmful to human beings and their produce. According to EPA (Environmental Protection Agency), organic pesticides can be divided into 4 main categories: organophosphates, carbamates, organochlorines and pyrethroids. Persistent Organic Pollutants are toxic chemicals that persist in the environment and biomagnify in the food chain.

Organochlorine pesticides (OCPs) are synthetic organochlorines which are lipophilic and hydrophobic. Their lipophilicity, hydrophobicity, stability to photo-oxidation, and low vapour pressure, and low chemical and biological degradation rates have led to their accumulation in biological tissues and the subsequent magnification of concentrations in organisms, progressing through to the food chain (Helberg et al., 2005). The various organochlorine pesticides are DDT and its isomers like DDE, DDD, etc.; cyclodienes like aldrin, dieldrin, endrin and hexachlorohexanes.

Agricultural development continues to remain the most important objective of Indian planning and policy. In the process of development of agriculture, pesticides have become an important tool as a plant protection agent for boosting food production. Further, pesticides play a significant role by keeping away many dreadful diseases from plants. Currently, India is the largest producer of pesticides in Asia and ranks 12th in the world for the use of pesticides.

A vast majority of the population in India is engaged in agriculture and is therefore exposed to the pesticides used in agriculture. Although Indian average consumption of pesticide is far lower than many other developed economies, the problem of pesticide residue is very high in India. Rampant use of these chemicals has given rise to several short term and long term adverse effect of these chemicals.
Milk and its products claim a unique place in human diet worldwide. With all its valuable constituents like fat, protein and lactose, in a balanced proportion, milk has special importance on nutritional standpoint. The contamination of milk is considered as one of the main dangerous aspects in the last few years. Due to the lipophilic nature of organochlorine pesticides, they easily concentrate in fatty food like milk leading to bioconcentration and biomagnifications through food chain.

Dhanbad is the most populous city of Jharkhand having a total population of 1,195,298. Huge portion of the population starting from infants to youth to aged people have milk as a daily constituent of their diet. Per capita availability/day of milk in Dhanbad is 152g (Directorate of Economics and Statistics). Use of pesticides in sectors like agriculture, mining industry, health program for the control of some major disease like malaria, filariasis, dengue, cholera, louse borne typhus, enhances the problem of pesticide contamination in Dhanbad city. The pesticide residue level in bovine milk is a measure of the incidental exposure and/or average levels of the persistent pesticides which is mainly through the food chain in and around Dhanbad city. So, by determining the pesticide residue contents in bovine and human milk, an estimation of Dhanbad region environmental contamination was made which may be of great value for scientific and public health knowledge. Also comparison of the obtained pesticide residue level with WHO recommended Maximum Residue Limit (MRL) was done with reference to possible health hazards in human/infants.

The present investigation on “Pesticide Residues in Bovine and Human Milk in Dhanbad City, Dhanbad, Jharkhand” was carried out in the Department of Rural Development and Agricultural Production (RDAP), North Eastern Hill University, Tura Campus, Tura. The collection of bovine and human milk samples and the analytical procedures (extraction and clean up of samples, estimation of pesticide residues) was done.
within the period of August 2014 to May 2015 which included the three seasons summer, rain and winter.

Ten (10) major locations of Dhanbad city i.e. Saraidhela (A), Bhuipore (B), Bartand (C), Jharudih (D), Rangatand (E), Hirapur (F), Bank More (G), Wasseypur (H), Matkuria (I) and Dhaunsar (J) were chosen for collection of bovine milk samples. Sample collection for both cow and buffalo milk was done from 6 dairy farms of each of the 10 locations, for 3 times in each season i.e. rainy, winter and summer. Therefore, total number of cow and buffalo milk samples collected was 540 and 540, respectively. For human milk sample collection 3 maternity hospitals and 1 nursing home was selected. From each maternity hospital and nursing home (total 4), milk samples were collected randomly from 5 different lactating women in all the three seasons i.e. rainy, winter and summer. The total number of human milk samples collected was 60. The samples were extracted in the laboratory of the Department of Environmental Science and Engineering of Indian School of Mines (ISM), Dhanbad, Jharkhand. The GC analysis of the extracted samples was also done in the same laboratory. Extraction of the samples was done by a method described by Faubert Maunder et al (1964), with certain modification by Dhaliwal and Kalra (1978). Pesticide residues in n-hexane layer were cleaned from fat and co-extractives by acid digestion method as mentioned by Veirov and Ahaaronson (1978), Kapoor et al (1980), Kapoor and Kalra (1988). Estimation of the pesticide residues was done with gas liquid chromatograph.

All sets of data were statistically analyzed by using SPSS Version 20 software (SPSS.Inc., Chicago, IL, USA) following statistical designs CRD and FRBD as suggested by Gomez and Gomez (1984) and Panse and Sukhatme (1954) respectively. Seasonal variation was studied by comparing the data of each season with the other for each OCP. Here the ANOVA was performed to see whether any significant level of difference exists among the OCPs for the seasons and locations. Then the paired t-test was performed to see if the data for
each season and location was significantly different from the other season and location. Correlation was also performed in order to see whether any significant relation exists among the level of OCPs in the different seasons. Comparison of the obtained pesticide residue level in both bovine and human milk with WHO/FAO/FSSAI recommended Maximum Residue Limit (MRL) was done in order to study the possible health hazards of the particular pesticides in human/infants.

The pesticide residue analysis showed that bovine milk (cow and buffalo) in different locations of Dhanbad city was contaminated with OCP residues of Aldrin, α HCH, β HCH, γ HCH, p,p’-DDE, p,p’-DDD, o,p’-DDT, p,p’-DDT, α Endosulfan, β Endosulfan and Endosulfan Sulfate. Whereas human milk samples were contaminated with OCP residues of α HCH, β HCH, γ HCH, p,p’-DDE, p,p’-DDD, o,p’-DDT, p,p’-DDT and Endosulfan Sulfate.

The level of aldrin concentration (mean) throughout the year in cow and buffalo milk was 0.101896 mg/ml and 0.132343 mg/ml, respectively. High concentration of aldrin in the milk samples reveals the increased improper use of this pesticide for agricultural and commercial purposes. The highest concentration of aldrin residue was found in the soil, water and air of Bartand (C) and Jharudih (D) making it highly contaminated while Bank More (G) is affected the least by aldrin contamination. The difference in the level of aldrin contamination in different locations of Dhanbad city might possibly be due to difference in the level of pesticide use, fodder supply, breed of cow and buffalo chosen for milk collection and health of animal. Aldrin was not detected in case of human milk throughout the year.

The level of α HCH concentration (mean) throughout the year in cow and buffalo milk was 0.028738 mg/ml and 0.044568 mg/ml, respectively. The level of β HCH concentration (mean) throughout the year in cow and buffalo milk was 0.104714 mg/ml and 0.158022 mg/ml, respectively. The level of γ HCH concentration (mean) throughout the year in cow and buffalo milk was 0.045706 mg/ml and 0.071906 mg/ml, respectively. The level of
∑ HCH concentration (mean) throughout the year in cow and buffalo milk was 0.229639 mg/ml and 0.274496 mg/ml, respectively. The possible reason for high HCH concentration was the extensive commercial use of technical grade HCH especially by the health departments for the control of malaria. The presence of various isomers of HCH reveals the rapid metabolic conversion of technical grade HCH into its more persistent and toxic isomers.

It was found that Wasseypur (H) and Bank More area (G) has high α HCH residue contamination while Dhaunsar (H) and Bhuipore area (B) has high β HCH and γ HCH contamination, respectively.

The level of α HCH, β HCH and γ HCH concentration (mean) throughout the year in human milk was 0.003319, 0.087468 and 0.037045 mg/ml, respectively. The level of ∑ HCH concentration (mean) throughout the year in human milk was 0.127832 mg/ml. Presence of α HCH in the milk samples reveals the increased improper use of this pesticide for agricultural (mostly past use) and commercial purposes for eg in Malaria Eradication Program and other disease vector control practice by Health Departments. It was observed that milk samples of lactating women from R C Hazra Memorial Hospital (H4) of Bank More area showed high α HCH residue contamination while milk samples of lactating women from Park Clinic Nursing Home (H2) of Hirapur area and Dwarka Das Jalan Memorial Hospital (H3) of Bartand area showed high β HCH and γ HCH contamination, respectively. The irregular and wide spread detection of HCH found in the milk samples of lactating women admitted in hospitals and nursing home of different locations (the woman admitted in a particular hospital, was not necessarily the resident of that particular area) suggests that HCH and its isomers persists in the environment throughout Dhanbad. The difference in the level of α HCH, β HCH and γ HCH contamination in different locations of Dhanbad city might be due to the difference in food habit and health of the mothers from whom milk had been collected.
The level of p,p’-DDE concentration (mean) throughout the year in cow and buffalo milk was 0.084480 mg/ml and 0.079709 mg/ml, respectively. The level of p,p’-DDD concentration (mean) throughout the year in cow and buffalo milk was 0.012606 mg/ml and 0.022953 mg/ml, respectively. The level of o,p’-DDT concentration (mean) throughout the year in cow and buffalo milk was 0.002151 mg/ml and 0.001988 mg/ml, respectively. The level of p,p’-DDT concentration (mean) throughout the year in cow and buffalo milk was 0.023813 mg/ml and 0.025545 mg/ml, respectively. The level of $\sum$ DDT concentration (mean) throughout the year in cow and buffalo milk was 0.123051 mg/ml and 0.130195 mg/ml, respectively. High concentration of HCH and its isomers in the milk samples reveals the increased improper use of this pesticide for agricultural (mostly past use) and commercial purposes and its conversion to its metabolites. The reason for the presence of high concentration of DDT and its analogues in the environment is its continued use for the National Malaria Eradication Program (NMEP) of Govt. of India. The above result reveals that area Jharudih (D) has high p,p’-DDE residue contamination while area Jharudih (D) and Matkuriya (I) has high p,p’-DDD contamination. High o,p’-DDT contamination was found in Bhupore (B) and Jharudih area (D). High p,p’-DDT contamination was found in Bhupore area (B). This shows Bhupore (B) and Jharudih (D) area of Dhanbad city was highly contamination with DDT residue and its metabolites. From the above result, it can also be stated that Rangatand (E) area was having lower contamination of DDT and its metabolites.

The level of p,p’-DDE, p,p’-DDD, o,p’-DDT and p,p’-DDT concentration (mean) throughout the year in human milk was found to be 0.992252, 0.025245, 0.000468 and 1.024617 mg/ml respectively. The level of $\sum$ DDT concentration (mean) throughout the year in human milk was found to be 2.042582 mg/ml. The high level of HCH and its isomers finds entry into the human body through contaminated fruits, vegetables, meat, milk and milk products, etc. feed, drinking contaminated water, breathing contaminated air, contact with
contaminated soil. The above result reveals that milk samples of lactating women from Park Clinic Nursing Home (H2) of Hirapur area showed high p,p’-DDE residue contamination while milk samples of lactating women from R C Hazra Memorial Hospital (H4) of Bank More area showed high p,p’-DDD, o,p’-DDT and p,p’-DDT contamination. As the women admitted in a particular hospital, was not necessarily the resident of that particular area, it cannot be ascertained that Bank More area people has high DDT contamination in their body. Hence it can be suggested that DDT and its isomers persists in the environment throughout Dhanbad.

The level of $\alpha$-Endosulfan concentration (mean) throughout the year in cow and buffalo milk was 0.001944 mg/ml and 0.003794 mg/ml, respectively. The level of $\beta$-Endosulfan concentration (mean) throughout the year in cow and buffalo milk was 0.002301 mg/ml and 0.003207 mg/ml, respectively. The level of Endosulfan Sulfate concentration (mean) throughout the year in cow and buffalo milk was 0.000307 mg/ml and 0.000504 mg/ml, respectively. The level of $\sum$ Endosulfan concentration (mean) throughout the year in cow and buffalo milk was 0.004552 mg/ml and 0.007506 mg/ml, respectively. Lower concentration of Endosulfan isomers in the milk samples may be explained by the fact that endosulfan and its isomers can leave the body through urine just a few days after exposure.

The above result reveals that area Bhuipore (B) has high $\alpha$ HCH residue contamination while area Bhuipore (B), Jharudih (D) and area Bhuipore (B), Wasseypur (H) has high $\beta$-Endosulfan and Endosulfan Sulfate contamination, respectively. From the above result, it can be depicted that highest contamination of endosulfan and its isomers is in Bhuipore (B) area. The difference in the level of $\alpha$-Endosulfan, $\beta$-Endosulfan and Endosulfan Sulfate contamination in different locations of Dhanbad city might possibly be due to difference in the level of pesticide use, fodder supply, breed of cow and buffalo chosen for milk collection and health of animal.
α-Endosulfan and β-Endosulfan was not detected in case of human milk in any of the places of study throughout the year. This may be due to the fact that the maximum percentage of Endosulfan that entered the cow and buffalo body was from their food sources oat, hay straw as well as oil seeds (Wedberg et al 1978), which are not the feed of humans. The level of Endosulfan Sulfate concentration (mean) throughout the year in human milk was found to be 0.000072 mg/ml, respectively. The level of ∑ Endosulfan concentration (mean) throughout the year in human milk was found to be 0.000072 mg/ml. The presence of endosulfan sulfate in human milk suggested its higher persistent level in comparison to the other isomers of endosulfan. The above result reveals that milk samples of lactating women from Park Clinic Nursing Home (H2) of Hirapur area showed high Endosulfan Sulfate residue contamination. The difference in the level of Endosulfan Sulfate contamination in different locations of Dhanbad city might be due to the difference in food habit and health of the mothers from whom milk had been collected.

The level of aldrin, HCH, DDT and endosulfan concentration throughout the year was found to be 0.101896, 0.229639, 0.123051 and 0.004552 mg/ml, respectively in cow milk whereas the level of aldrin, HCH, DDT and endosulfan concentration throughout the year was found to be 0.132343, 0.274496, 0.130195 and 0.007506 mg/ml, respectively in buffalo milk. From the above data, it can be analyzed that the highest amount of OCP residues was found in buffalo milk as compared to that in cow milk. The reason for higher OCP residue levels in buffalo milk than cow milk due to the high fat content (7.47%) of the buffalo milk as compared to cow milk (3.66%), as these OCPs concentrate in the fatty tissues of the body. Another significant reason for higher concentration of OCP residues in buffalo milk than cow milk is due to difference in dietary habit of buffalo, like different fodder and more diet than the cows.
The mean aldrin concentration in cow milk was higher (0.1652883 mg/ml) in the winter months compared to summer (0.098732 mg/ml) and rainy (0.041668 mg/ml) and the data obtained for difference in aldrin concentration in three seasons was found to be significant (P value= 0.049; P ≤ 0.05). The mean aldrin concentration in buffalo milk was higher (0.233166 mg/ml) in the winter months compared to summer (0.110582 mg/ml) and rainy (0.053280 mg/ml). The data obtained for difference in aldrin concentration in different locations was found to be highly significant (P value= 0.001; P ≤ 0.01). The possible reason for this trend might be that the influences of heat, wind and rain, which are the characteristics of the summer and rainy seasons, are very low during winter seasons so that the dissipation of pesticide residues does not take place very rapidly. This reveals that there is significant effect of seasonal factors on the level of aldrin accumulation in the milk samples in Dhanbad city.

The difference in aldrin concentration in different locations in cow and buffalo milk was found highly significant (P value= 0.000; P ≤ 0.01). The possible reason may be possibly due to difference in the level of pesticide use, fodder supply, breed of cow and buffalo chosen for milk collection and health of animal.

In case of human milk, aldrin residue was not detected at all places of the study area throughout the year.

The mean $\sum$ HCH concentration in cow milk was higher (0.339717 mg/ml) in the rainy months compared to summer (0.215100 mg/ml) and winter (0.134100 mg/ml) and data obtained for difference in $\sum$ HCH concentration in three seasons was found to be highly significant (P value= 0.001; P ≤ 0.01). The mean $\sum$ HCH concentration in buffalo milk was higher (0.458112 mg/ml) in the winter months compared to summer (0.09801 mg/ml) and rainy (0.267367 mg/ml) and the data obtained for difference in $\sum$ HCH concentration in three seasons was found highly significant (P value= 0.000; P ≤ 0.01). This reveals that there is
significant effect of seasonal factors on the level of $\Sigma$ HCH accumulation in the milk samples in Dhanbad city.

The difference in $\Sigma$ HCH concentration in different locations in cow and buffalo milk was found highly significant (P value= 0.000; $P \leq 0.01$).

From the above observation, it can be depicted that there is highly significant difference in the level of HCH isomers in three different seasons both in case of cow and buffalo milk. On the other hand, the trend of seasonal variation of HCH isomers was different in cow and buffalo milk. In cow milk, the highest HCH concentration was found in winter months while in buffalo milk, the highest HCH concentration was found in rainy months. This is because the effect of seasonal factors has been more in case of buffalo milk.

The mean $\Sigma$ HCH concentration was higher (0.245403 mg/ml) in the rainy months compared to summer (0.120727 mg/ml) and winter (0.017367 mg/ml) and the data obtained for difference in $\Sigma$ HCH concentration in three seasons was found to be significant (P value= 0.014; $P \leq 0.05$). From the above observation, it can be depicted that there is significant difference in the level of HCH isomers in three different seasons in case of human milk. This reveals that there is significant effect of nature of OCP residue metabolism inside the animal body along with seasonal factors on the level of HCH accumulation in the milk samples in Dhanbad city.

The difference in $\Sigma$ HCH concentration in different locations was found highly significant (P value= 0.002; $P \leq 0.01$). This may be due to the difference in food habit and health of the mothers from whom milk had been collected.

The mean $\Sigma$ DDT concentration in cow milk was higher (0.211837 mg/ml) in the winter months compared to summer (0.113602 mg/ml) and rainy (0.043713 mg/ml) and data obtained for difference in $\Sigma$ DDT concentration in three seasons was found highly significant.
The mean $\sum$ DDT concentration in buffalo milk was higher (0.247223 mg/ml) in the winter months compared to summer (0.085170 mg/ml) and rainy (0.058192 mg/ml) and the data obtained for difference in $\sum$ DDT concentration in three seasons was found significant (P value= 0.013; P ≤0.05). This reveals that there is significant effect of seasonal factors on the level of $\sum$ DDT accumulation in the milk samples in Dhanbad city.

The difference in $\sum$ DDT concentration in different locations in both cow and buffalo milk was found highly significant (P value= 0.000; P ≤0.01).

From the above observation, it can be depicted that there is highly significant difference in the level of DDT and its isomers in three different seasons both in case of cow and buffalo milk. The trend of seasonal variation of DDT isomers was similar in both cow and buffalo milk, i.e. the concentration of DDT and its isomers was maximum in the winter season.

The mean $\sum$ DDT concentration was higher (2.286849 mg/ml) in the winter months compared to summer (2.102541 mg/ml) and rainy (1.738355 mg/ml) and data obtained for difference in $\sum$ DDT concentration in three seasons was found non significant (P value= 0.904; P ≥0.05). From the above observation, it can be depicted that there is non significant difference in the level of DDT and its isomers in three different seasons in case of human milk. This reveals that there is non significant effect of seasonal factors on the level of DDT accumulation in the milk samples in Dhanbad city. The difference in $\sum$ DDT concentration in different locations was found non significant (P value= 0.387; P ≥0.05).

The mean $\sum$ Endosulfan concentration in cow milk was higher (0.005958 mg/ml) in the winter months compared to summer (0.004765 mg/ml) and rainy (0.002931 mg/ml) and data obtained for difference in $\sum$ Endosulfan concentration in three seasons was found non
significant (P value= 0.456; P ≥0.05). The mean $\sum$ Endosulfan concentration in buffalo milk was higher (0.010073 mg/ml) in the winter months compared to summer (0.007111 mg/ml) and rainy (0.005333 mg/ml) and data obtained for difference in $\sum$ Endosulfan concentration in three seasons was found non significant (P value= 0.362; P ≥0.05). This reveals that there is non significant effect of seasonal factors on the level of p,p'-DDT accumulation in the milk samples in Dhanbad city.

The difference in $\sum$ Endosulfan concentration in different locations in cow milk was found significant (P value= 0.017; P ≤0.05) and highly significant (P value= 0.001; P ≤0.01) in buffalo milk.

From the above observation, it can be depicted that there is non significant difference in the level of endosulfan isomers in three different seasons both in case of cow and buffalo milk. The trend of seasonal variation of DDT isomers was similar in both cow and buffalo milk, i.e. the concentration of endosulfan isomers was maximum in the winter season.

$\alpha$-Endosulfan and $\beta$-Endosulfan residue were not detected in case of human milk at all places of study throughout the year. The mean $\sum$ Endosulfan concentration was higher (0.000080 mg/ml) in the winter months compared to summer (0.000075 mg/ml) and rainy (0.000060 mg/ml) and data obtained for difference in $\sum$ Endosulfan concentration in three seasons was found non significant (P value= 0.925; P ≥0.05). From the above observation, it can be depicted that there is non significant difference in the level of endosulfan isomers in three different seasons in case of human milk. This reveals that there is non significant effect of seasonal factors on the level of endosulfan isomers accumulation in the milk samples in Dhanbad city.

The difference in $\sum$ Endosulfan concentration in different locations in human milk was found non significant (P value= 0.412; P ≥0.05). This reveals that there is non significant
effect of seasonal factors on the level of endosulfan isomers accumulation in the milk samples in Dhanbad city.

From the correlation analysis of OCP residues for all seasons in cow, buffalo and human milk, both positive and negative correlation was found among the various OCP residues. It was also found that all the isomers of OCP residues like for DDT, HCH and Endosulfan, showed a positive correlation. The possible reason for this might be due to the fact that the isomers of the pesticides are produced as a result of metabolic conversion of the respective same technical grade pesticide.

The mean concentration of aldrin (mg/ml) detected in the cow and buffalo milk samples is 0.101896 and 0.132343 mg/ml, respectively that does not exceed the MRL of aldrin (0.15 mg/ml) as recommended by WHO/FAO/FSSAI. The locations affected with high aldrin contamination were C (Bartand), D (Jharudih), F (Hirapur). It was found that out of total 60 samples analyzed, none of the samples showed the presence of detectable amount of aldrin concentration. The possible reasons may be limited recent aldrin exposure and its rapid breakdown hence elimination from the body.

The mean concentration of HCH (mg/ml) detected in the cow and buffalo milk samples is 0.229639 and 0.274496 mg/ml, respectively that exceeded the MRL of HCH (0.10 mg/ml) as per the recommendation of WHO/FAO/FSSAI. The locations affected with high HCH contamination were B (Bhuipore), E (Rangatand), F (Hirapur), G (Bank More), H (Wasseyapur), I (Matkuriya), J (Dhaunsar). The mean concentration of HCH (mg/ml) detected in the human milk samples 0.127832 mg/ml that exceeded the MRL of HCH (0.10 mg/ml) as recommended by WHO/FAO/FSSAI. The hospitals and nursing home from where high HCH contamination were detected in human milk samples were H2 (Park Clinic Nursing Home, Hirapur area), H3 (Dwarka Das Jalan Memorial Hospital, Bartand area), H4 (R C Hazra Memorial Hospital, Bank More area).
The mean concentration of DDT (mg/ml) detected in the cow and buffalo milk samples is 0.123051 and 0.130195 mg/ml that does not exceed the MRL of DDT (1.25 mg/ml) as per the recommendation of WHO/FAO/FSSAI. None of the locations in Dhanbad city were affected with very high DDT contamination. The mean concentration of DDT (mg/ml) detected in the human milk samples 2.042582 mg/ml that exceeded the MRL of DDT (1.25 mg/ml) as recommended by WHO/FAO/FSSAI. The hospitals and nursing home from where high DDT contamination were detected in human milk samples were H2 (Park Clinic Nursing Home, Hirapur area), H3 (Dwarka Das Jalan Memorial Hospital, Bartand area), H4 (R C Hazra Memorial Hospital, Bank More area).

The mean concentration of Endosulfan (mg/ml) detected in the cow and buffalo milk samples is 0.004552 and 0.007506 mg/ml that does not exceed the MRL of Endosulfan (0.01 mg/ml) as per the recommendation of WHO/FAO/FSSAI. The locations affected with high Endosulfan contamination were B (Bhuiapore), D (Jharudih), E (Rangatand). The mean concentration of Endosulfan (mg/ml) detected in the human milk samples 0.000072 mg/ml that exceeded the MRL of DDT (0.01 mg/ml) as recommended by WHO/FAO/FSSAI. It was also found that out of total 60 samples analyzed, in none of the samples the Endosulfan level exceeded the MRL for Endosulfan recommended by WHO/FAO/FSSAI.

From the above observation, it can be depicted that bovine and human milk in Dhanbad city were contaminated with residues of highly persistent OCPs like aldrin, HCH, DDT and endosulfan. This indicates an alarming risk to the health of humans/children population of Dhanbad city due to pesticide exposure. The acute health effects of OCP residues detected may be irritation of the skin, nausea, dizziness, diarrhea and severe reactions to people having asthma whereas the chronic health effects may include cancer and other tumors, brain and nervous system damage, birth defects, infertility and other reproductive problems, damage to the liver, kidneys, lungs and other body organs.
The OCP residue analysis showed that almost all bovine and human milk were contaminated with residues of highly persistent OCPs like aldrin, HCH, DDT and endosulfan. The reasons may be improper handling of pesticides and feeding the animals on contaminated feeds. The responsible bodies (Government and the NGOs) should take into account that the above mentioned reasons are addressed to allow quality milk (residue free) to the processors and the consumers. This would enhance the dairy sector economically and would also serve the purpose of providing nutritious food to its people for their health.