A Review on Levels of Organochlorine Pesticides in Animal Milk

Swapnil Rai[1], S P Bajpai[2]

Assistant Professor[1] and Professor[2]
Department of Environmental Science,
Amity University Madhya Pradesh, Gwalior, India – 474005

Abstract: **Organochlorine pesticides are used to control the mosquitoes and agricultural pests worldwide. These compounds were very popular and heavily used agriculture and public health due to cheap cost and versatile action against various pests. DDT (Dichlorodiphenyl trichloro ethane) and HCH (Hexachlorohexane) were the important organochlorine insecticides which were used for control of mosquitoes in different health programmes in India. Both DDT and HCH are lipophilic compounds and get accumulated in tissues of animals and environmental components. These compounds undergo the biomagnifications process and persist for the longer period of time. The contamination of milk is a matter of concern and efforts must be taken to assure the quality of milk by dairy industries. The presence of organochlorines and other chemical in animal milk sample have raised a point about the toxicological impacts of these chemicals on an infant's development. In the present articles attempts are made to collect the available information about the contamination of animal milk by organochlorine pesticides.**

***INDEX ITEMS*- Organochlorine Pesticides, DDT, HCH, Animal Milk**

1. INTRODUCTION

The use of synthetic pesticides started in 1948–49 with the use of DDT for malaria control and HCH for locust control (Gupta, 2004; NAMS 2005). DDT, an organochlorine pesticides showed its spectacular success in Europe by eradicating human typhus transmitted by body lice. It was also effective against malaria vector as in 1940s. It showed a decisive role in the eradication of malaria from Europe and United states and within a very short time, DDT got a unique position by saving millions of lives and by preventing disease outbreaks than any other manmade chemicals in history. Similar success stories of near eradication of malaria were achieved in early 1960s in India and Sri Lanka (Dash *et al.*, 2007).

Animal milk is nutritionally rich and has biological potential to increase the immunity with a good source of energy, fat, minerals, vitamins and proteins. It is helpful in the development of infants and contamination of milk with organochlorines may cause neurodevelopment delay (Ribas fito *et al.*, 2003), reproductive effects, preterm and immune-toxicity (Longnecker *et al.*, 2001; Cooper *et al.*, 2004; Dalvie *et al.*, 2004). The exposures of these chemicals in milk can be harmful for all humans primarily infants. Milk is considered as a perfect food widely used in all segments of the population in all stages of life (Davies *et al*., 1986; Jhon *et al.*, 2001).

2. CONTAMINATION PROFILE OF DDT AND HCH IN ANIMAL MILK

Milk is nutritional component of the human food and if it is contaminated then it can act as ways of contamination to the humans. There are various reports regarding the contamination of milk by the organochlorines pesticides. Losada et al., (1996) reported the residues of organochlorines in the bovine milk samples of Spain and found that all samples were contaminated with these chemicals. The presence of HCH isomers and DDT metabolites were found in the pasteurized milk samples of Spain although the concentration was under permissible limits of European standards (Martinez et al., 1997). Organochlorine pesticides residues were found in pasteurized milk, fresh milk, and raw milk of Hong Kong during a survey from 1993 to 1995. Mostly samples were showed the presence organochlorines (Wong et al., 1997). Waliszewski et al., (1997) analysed cow's milk samples of Mexico and reported the presence of organochlorine pesticides residues. The concentrations of organochlorine pesticides were detected in different human food and wildlife including animal milk samples from Neatherland by Jong et al., (2001). In an inter laboratory study organochlorine pesticide were detected in animal milk, beef fat, fish, and egg samples of France (Bordet et al., 2002).

Zhong et al., (2003) analysed milk samples collected from supermarkets of Beijing, China for the organochlorine pesticides contamination and reported that all the samples were have the residues of DDT metabolites and HCH isomers in higher concentration above the standard limit prescribed by WHO. Pardio et al., (2003) investigated the cow and bovine milk samples for the levels of organochlorine pesticide residues from the Mexico and concluded that the concentration of DDT and HCH in cattle's results in high levels of organochlorines in dairy milk and a potential health risk for consumers. In the study of 150 cow milk samples from tropical regions of Mexico organochlorines pesticdes were detected in all samples. Results were also revealed that the concentration of HCH isomers and DDT metabolites were lower than previous studies (Waliszewski et al., 2003). Armendariz et al., (2004) detected the organochlorine pesticides in cow milk samples in Spain. They developed and validated the methods for the analysis of many DDT metabolites and HCH isomers from milk samples. The concentration of different organochlorine pesticides in cow milk samples of Qena and Sohag were reported by the Wahab et al., (2004). The workers studied the concentration of DDT, lindane, endrin, epoxide, dieldrin and heptachlor in fresh cow milk samples and found that 95% samples from Quena and 70% of the samples from Sohana contain these chemicals. As the milk is loaded with many

chemicals contaminants therefore milk samples of Italy were analyzed for the pesticdes residues analysis and found the levels within the permissible limits (Ghidini et al., 2005). Wong et al., (2005) observed that milk samples of China are contaminated with different chemicals including organochlorine pesticides.

Organochlorines pesticides like HCH isomers and DDT metabolites were detected in the milk samples of Ghana (Ntow et al., 2008). Fontcuberta et al., (2008) investigated the accumulation level of chlorinated pesticdes in the marketed food items including milk and other dairy food items of Barcelona and found the concentration of lindane and endosulfan α and β HCH in lowere concentration. They observed a decreasing pattern of these chemicals in all the samples and concluded after the comparison of previous studies from 1989–2000 periods that gradual disappearance of these chemicals is due to the Worrldwide implementation of current regulatory agreements. Darko et al., (2008) determined the concentration of six organochlorine pesticides viz lindane, aldrin, dieldrin, endosulfan, DDT, and DDE in three dairy products from six communities in the Kum-asi metropolis in Ghana. Ashnagar et al., (2009) have reported residues of organochlorine pesticides in cow milk samples from the Ahwaz city of Iran by HPLC methods. They reported measurable amount of Lindane, DDT in all the milk samples and concentrations were exceeded the maximum permissible limits recommended by Food and Agricultural Organization and World Health Organization. Hernandez et al. (2010) investigated the concentration of DDT, endrin and aldrin in the milk samples of Cow collected from Colombia after the ban of these compounds in 1986. Dirtu et al., (2010) reported the concentration of different organo-halogenated contaminants in food items including dairy products of Romania and found contaminated with these chemicals especially levels of contamination with HCHs in milk-based products were found higher than European maximum residue levels. In another study from Colombia organochlorines were reported in the pasteurized milk samples and concentration was found more than the WHO prescribed limits and recommendation was given for residents not to consume milk (Pinedo et al., 2010). The occurrence of organochlorine and other chemicals in dairy cows and buffalos of Belgium and its association with reproductive performance have been investigated and found that its disrupt the endocrine system of animals (Petro et al 2010).

Bayat et al., (2011) studied the presence of DDT metabolites and HCH isomers in the psteurized and sterilized milk sample of Tehran province in Iran. The compounds were found within the prescribed limit of WHO. Bulut et al., 2011 studied the presence of 16 organochlorine pesticides in the sheep's milk and it was followed 14 in buffalo's milk and 11 in cow's milk. In all the the samples β HCH was found dominated isomer of HCH. The highest concentration of β HCH was detected in bovine milk followed by cow and sheep milk samples respectively. Kampire et al., (2011) recorded the concentration of DDT metabolites, aldrin dieldrin, lindane and endosulfan in the fresh and pasteurized milk samples from Kampala, Uganda and concluded that the contaminated milk is likely to pose threat to the consumer's life. Luzardo et al., (2012) have investigated the contamination of conventional and organic brand of milk of Canary island of Spain with organochlorines. Gutiérrez et al., (2012) analysed 36 bovine milk samples collected from the Chiapas State, Mexico for concentration of organochlorine pesticide residues. The concentartion was found within the prescribed limit of WHO.

Schettino et al., (2013) observed the organochlorines in the milk samples of two goat species of Alpine and Saanen from Mexico. Gebremichael et al., (2013) were analyzed and compared the profile of organochlorine pesticides in human and cow milk samples collected from Asendabo, Serbo and Jimma in South-West Ethiopia. The concentration of DDT metabolites were found alarming and were higher than the previously reported. Avancini et al., 2013 concluded that the milk is the important product of human diet and reported the measurable amount of organochlorines pesticides in bovine milk samples of Brazil. Witczak et al., (2013) assessed the daily intake level of organochlorine pesticides in the population of Poland afetr the consumption of contaminated milk. They concluded that the contaminated milk directly pose the threat to human health. A two year survey was carried out during 2008-10 to analyzed the concentartion of residues of organochlorine pesticides in the cow milk samples of Mexico and concluded that the pesticide concentration was found within the standard permissible limit (Gutierrez et al., 2013). Deti et al., (2014) reported the levels of six organochlorines pesticides like DDT metabolites and endosulfan in the milk samples of goat and cow from the different regions of Ethiopia. Zheng et al., (2014) investigated the 30 organochlorine pesticide residues in milk and milk powder samples during a multi-residue analysis and method development. Kuba et al., (2015) have done a comparative analysis in between cow milk samples collected from agricultural and industrial area of Poland and concluded that the samples of agricultural area had more concentration of DDT as compare to the samples of industrial area. Tsakiris et al., (2015) analysed the 196 pateurized cow milk samples collected from market of Greek and reported the measurable concentration of DDT metabolites which were under the prescribed limit of European Union.

In India many workers from different states have reported the contamination profile of DDT and HCH in animal milk samples. Kapoor et al., (1980) reported the DDT and HCH residues in the bovine milk samples of Punjab region where the DDT and HCH sprayed for the control of Malaria vector. The samples were found contaminated with these chemicals up to significant levels. Battu et al., (1989) investigated the contamination of bovine milk samples with DDT and HCH used under the malaria control programme. The samples were collected from the Ludhiana and Sangrur of Punjab and were found contaminated with the DDT and HCH residues. The milk, butter and Ghee samples were found contaminated with HCH and DDT residues collected from Uttar Pradesh during a study undertaken by Kaphalia et al., (1990). Mukherjee et al., (1993) observed contamination of dairy milk samples in and around Delhi with organochlorione pesticides and concluded that samples have high levels of pesticides above the WHO limits.

Dua et al., (1997) analyzed the bovine milk samples of Bahadrabad, BHEL Ranipur and Haridwar city of Uttarakhand for the organochlorines pesticides residues and found the contamination of milk by HCH and DDT residues. Kalra et al., (1999) have done a multicentric study in which they collected dairy milk samples from different geographical regions of India. The samples were collected from 12 states of India and analysed for the concentration of HCH isomer and DDT metabolites. The levels of organochlorines were found more than the reported by other workers of the same period. John et al., (2001) have analyzed the dairy and buffalo milk samples of Jaipur, Rajasthan and reported the presence of DDT metabolites and HCH isomers in all the samples. Battu et al., (2004) reported the levels of DDT and HCH in the milk and butter of Ludhiana district of Punjab. The

workers reported that few samples were found exceeded concentration above the maximum permissible limit. Lindane was detected dominantly among HCH isomers and p,p DDE was among DDT metabolites. Kumar et al., (2005) have investigated the concentration of different organochlorines in the milk samples collected from Agra Uttar Pradesh. Sharma et al., (2007) reported the residues of DDT and HCH in 147 bovine milk samples collected from 14 different districts of Haryana during 1998-99. Out of all samples collected 8 % samples found to exceed the maximum residue limit of WHO for HCH. The concentrations of beta-HCH and p,p'-DDE were reported with maximum concentration as compared to other isomers and metabolites of HCH and DDT. Nag et al., (2008) monitored the 325 bovine milk samples of Bundelkhand region of India. Out of total, 63.38% samples were contaminated with different organochlorine pesticide residues. Among HCH isomers α-isomer was maximum followed by δ-, γ- and β HCH while total DDT comprising of DDT, DDE and DDD was detected in 114 samples. Kaushik et al., (2011) have reported the changing pattern of organochlorine pesticide residues in bovine milk samples of rural areas of Haryana. The investigation was undertaken during 1992-98 from 14 districts of Haryana. The workers found that the mean residues of HCH in bovine milk have declined by 67.5% while mean levels of DDT have decreased by 92.8% than previous year study. Singh et al., (2013) monitored the 210 bovine milk collected from Nadia district of West Bengal for the organochlorine pesticide residues. The results showed that the lindane was detected in only 1 % of milk samples. Maurya et al., (2013) analyzed the milk samples of goat, cow and buffalo from Paliakalan of Uttar Pradesh for the pesticide residues and found the lower concentration of DDT and HCH than earlier studies of India. Aslam et al., (2013) reported the organochlorine pesticide residues in buffalo milk samples collected from different localities of Delhi. The presence of HCH, DDT and Endosulfan has been reported by the workers during study. Recently Rani *et al.*, (2015) reported the presence of DDT and HCH in the packaged milk samples collected from Haridwar, Uttarkhand and observed the decreasing trend of these pesticides from the milk samples.

CONCLUSION

The milk is the essential food item for the humans especially infants and kids and contamination of milk may lead to serious health problems in humans. The available data shows that contamination of animal milk by organochlorines was reported from most of the countries of World including India. A decreasing trend in the concentrations of DDT and HCH in milk samples were observed that may due to ban of DDT and HCH in agriculture and public health programme. But a continuous monitoring programme is needed to check the profile of these compounds in animal milk samples and other environmental components.

REFERENCES

[1] Armendáriz, C., Pérez, de Ciriza, J.A., Farré, R. (2004). Gas chromatographic determination of organochlorine pesticides in cow milk. *Int. J. Food Sci. Nutr.* **55**(3):215-21.

[2] Ashnagar, A., Gharib, N. N. and Cheraghi, F. M. (2009). Deter- mination of Organochlorine Pesticide Residues in Cow's Milk Marketed in Ahwaz City of Iran," *Int. J. Pharm.Tech. Res.* **1** (2): 247-251.

[3] Aslam, M., Rais, S. and Aslam, M. (2013). Quantification of organochlorine pesticide residues in buffalo milk samples of Delhi city, India. *J. Environ. Prot.*, **4**: 964-974.

[4] Avancini, R.M., Silva, I.S., Rosa, A.C., Sarcinelli, P.N., de Mesquita, S.A. (2003). Organochlorine compounds in bovine milk from the state of Mato Grosso do Sul-Brazil. *Chemos*. **90** (9): 2408-2413.

[5] Battu, R. S., Singh, B. and Kang, B. K. (2004). Contamination of liquid milk and butter with pesticide residues in the Ludhiana district of Punjab state, India. *Ecotoxicology and Environmental Safety*. **59**: 324–331.

[6] Battu, R.S., Singh, P.P., Joia, B.S., and Kalra, R.L. (1989). Contamination of bovine (buffalo, *Bubalus bubalis* (L.)) milk from indoor use of DDT and HCH in malaria control programmes. *Science of the Total Environ*. **86(3)**:281-287.

[7] Bayat, S., Esmaili Sari A., Bahramifar, N., Younesi, H., Dahmarde Behrooz R. (2011). Survey of organochlorine pesticides and polychlorinated biphenyls in commercial pasteurized milk in Iran. *Environ Monit Assess.* **175**(1-4):469-74.

[8] Bordet, F., Inthavong, D., Fremy, J.M. (2002). Interlaboratory study of a multiresidue gas chromatographic method for determination of organochlorine and pyrethroid pesticides and polychlorobiphenyls in milk, fish, eggs, and beef fat. J AOAC Int. **85**(6):1398-409.

[9] Bulut S., Akkaya L., Gok Veli, and Konuk M. (2011). Organochlorine pesticide residues in cow's, buffalo's and sheep's milk from Afyonkarahisar region, Turkey. *Environ Monit Assess.* ***181***:555 – 562.

[10] Cooper, G. S., Martin, S. A., Longnecker, M. P., San dler, D. P., and Germolec, D. R. (2004). Associations between Plasma DDE Levels and Immunologic Measures in African- American Farmers in North Carolina, *Environ. Health Persps*. **112** (10) :1080- 1084.

[11] Dalvie, M. A., Myers, J. E., Thompson, M. L., Robins, T. G., Dyer, S., Riebow, J., Molekwa, J., Jeebhay, M., Millar, R. and Kruger, P. (2004). The Long-Term Effects of DDT Expo sure on Semen, Fertility, and Sexual Function of Malaria Vectorcontrol Workers in Limpopo Province, *S. A. Environ Res*. **96** (1): 1-8.

[12] Dash, A.P., Raghavendra, K. and Pillai, M.K.K. (2007). Resurrection of DDT: A critical appraisal. *Ind. J. Med. Res*. **126**: 1-3

[13] Davies, J. F., Freed, V.H., Whittemore, F. W. (1986). "An Agro Medical Approach to Pesticide Management," Uni- versity of Miami School of Medicine, Coral Gables,

[14] Deti, H., Hymete, A., Bekhit, A.A., Mohamed, A.M., Bekhit, A. D. (2014). Persistent organochlorine pesticides residues in cow and goat milks collected from different regions of Ethiopia. *Chemos.* **106**:70-4.

[15] Dirtu, A.C., and Covaci, A. (2010). Estimation of daily intake of organohalogenated contaminants from food consumption and indoor dust ingestion in Romania. *Environ Sci. Technol*. **44**(16):6297-304.

[16] Dua, V.K., Pant, C.S. and Sharma, V.P. (1997). HCH and DDT residues in human and bovine milk at Hardwar, India. *Ind J. Malariol.* **34**(3):126-31.

[17] Fontcuberta, M. J. F., Arqués, J. R., Villalbí, M., Martínez, F., Centrich, E., Serrahima, L., (2008). Chlorinated organic pesticides in marketed food: Barcelona, 2001–2006. *Science of The Total Environmental.* **389**:52–57.
[18] Gebremichael, S., Birhanu, T., and Tessema, D.A. (2013). Analysis of organochlorine pesticide residues in human and cow's milk in the towns of Asendabo, Serbo and Jimma in South-Western Ethiopia. *Chemos.* **90**(5):1652-7.
[19] Ghidini S., Zanardi E., Battaglia A., Varisco G., Ferretti E., Campanini G., Chizzolini R. (2005). Comparison of contaminant and residue levels in organic and conventional milk and meat products from northern Italy. *Food Addit Contam.* **22**(1):9-14.
[20] Gupta, P.K. (2004). Pesticide exposure—Indian scene, *Toxicol.* **198**: 83–90.
[21] Gutierrez, R., Ortiz, R., Vega, S., Schettino, B., Ramirez, M.L., and Perez, J.J., (2013). Residues levels of organochlorine pesticide in cow's milk from industrial farms in Hidalgo, Mexico. *J Environ Sci Health B.* **48**(11):935-40.
[22] Gutiérrez, R., Ruíz, J.L., Ortiz, R., Vega, S., Schettino, B., Yamazaki, A., de Lourdes, Ramírez, M. (2012). Organochlorine pesticide residues in bovine milk from organic farms in Chiapas, Mexico. *Bull Environ Contam Toxicol.* **89**(4):882-7.
[23] Hernández M., Vidal J.V., Marrugo J.L. (2010). Organochlorine pesticides in cows'milk supplemented with cotton waste in San Pedro, Colombia. *Rev Salud Publica.* **12**(6):982-9.
[24] 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. *Envir. Internat*. **26**:231–236.
[25] Kalra, R.L., Kaur, H., Sharma, S., Kapoor. S.K., Kshirasagar, R.B., Vaidya, R.C., Sagade, R.B., Shirolkar, S.B., Dikshit, S.S., Raizada, R.B., Srivastava, M.K., Appaiah, K.M., Srinivasa, M.A., Usha Rani, M, Rama Rao, S.N., Toteza, G.S., Dasgupta, J., and Ghosh, P.K. (1999). DDT and HCH residues in dairy milk samples collected from different geographical regions of India – a multicentric study. *Food Addit. Contam.* **16**:411–417.
[26] Kampire, E., Kiremire, B.T., Nyanzi, S.A., and Kishimba, M. (2011). Organochlorine pesticide in fresh and pasteurized cow's milk from Kampala markets. *Chemos*. **84**(7):923-7.
[27] Kaphalia, B.S., Takroo, R., Mehrotra, S., Nigam, U., and Seth, T.D. (1990). Organochlorine pesticide residues in different Indian cereals, pulses, spices, vegetables, fruits, milk, butter, Deshi ghee, and edible oils. *J Assoc Off Anal Chem.* **73**(4):509-12.
[28] Kapoor, S.K., Chawla, R.P., and Kalra, R.L. (1980).Contamination of bovine milk with DDT and HCH residues in relation to their usage in malaria control programme. J *Environ Sci Health B*. **15** (5):545-57.
[29] Kaushik, C.P., Sharma, H.R., Gulati, D., and Kaushik, A. (2011). Changing patterns of organochlorine pesticide residues in raw bovine milk from Haryana, India. *Environ Monit Assess.* **182**(1-4):467-75.
[30] Kuba, J., Tomza-Marciniak, A., Pilarczyk, B., Tarasewicz, N., Pilarczyk, R., and Ligocki, M. (2015). Comparison of DDT and its metabolites concentrations in cow milk from agricultural and industrial areas. *J Environ Sci Health B***. 50**(1):1-7.
[31] Kumar, A., Baroth, A., Soni, I., Bhatnagar, P. and John, P.J. (2005). Organochlorine pesticide residues in milk and blood of women from Anupgarh, Rajasthan, India. *Environ Monit Assess.* **116**(1):1-7.
[32] Longnecker, M.P., Klebanoff, M.A., Zhou, H. and Brock, J.W.(2001). Association between maternal serum concentration of the DDT metabolite DDE and preterm and small-for-gestational-age babies at birth. *The Lancet.* **358**:110-114.
[33] Losada, A., Fernandez, N., Diez, M.J., Teran, M.T., Garcia, J.J., and Sierra, M. (1996). Organochlorine pesticide residues in bovine milk from Leon (Spain). *Sci Total Environ.* **181**(2):133-5.
[34] Luzardo, O.P., Almeida-González, M., Henríquez-Hernández, L.A., Zumbado, M., Alvarez-León, E.E., and Boada, L.D. (2012). Polychlorobiphenyls and organochlorine pesticides in conventional and organic brands of milk: occurrence and dietary intake in the population of the Canary Islands (Spain*). Chemos.* **88**(3):307-15.
[35] Martínez, M.P., Angulo, R., Pozo, R. and Jodral, M. (1997). Organochlorine pesticides in pasteurized milk and associated health risks. *Food Chem Toxicol.* **35**(6):621-4.
[36] Maurya, A. K., Kumar, A., Joseph, P.E. (2013). Trends in ambient loads of DDT and HCH residues in animal'sand mother'smilk of PaliakalanKheeri, Uttar Pradesh-India. *IJSR.* **3** (5):1-5
[37] Mukherjee, I. and Gopal, M. (1993). Organochlorine pesticide residues in dairy milk in and around Delhi. *JAOAC Int.* **76**:283–286.
[38] Nag, S.K. and Raikwar, M.K. (2008). Organochlorine pesticide residues in bovine milk. *Environ. Contam. Toxicol.* **80**:5–9.
[39] NAMS and T/NASTEC (2005). Technology of Application of Pesticides, Daya Publishing House, New Delhi, pp.109–125.
[40] Ntow, W.J., Tagoe, L.M., Drechsel, P., Kelderman, P., Gijzen, H.J. and Nyarko, E. (2008). Accumulation of persistent organochlorine contaminants in milk and serum of farmers from Ghana. *Environ. Res.* **106:** 17-26.
[41] Pardio, V.T., Waliszewski, K.N., Landin, L.A., and Bautista, R.G. (2003). Organochlorine pesticide residue in cow's milk from a tropical region of Mexico. *Food Addit Contam.* **20**:259–269.
[42] Petro, E.M., Covaci, A., Leroy, J.L., Dirtu, A.C., De Coen, W. and Bols, P.E. (2010). Occurrence of endocrine disrupting compounds in tissues and body fluids of Belgian dairy cows and its implications for the use of the cow as a model to study endocrine disruption. *Sci Total Environ.* **408** (22) : 5423-8.
[43] Pinedo, C.Y., Alvis-Estrada, L., and Alvis-Guzmán, N. (2010). Estimating exposure to organochlorine compounds from consuming pasteurised milk in Cartagena, Colombia. *Rev Salud Publica (Bogota).* **12**(1):14-26.
[44] Rani, S., Negi, R.K. (2015). Contamination profile of DDT and HCH in packaged milk samples collected from Haridwar, India. *Int. J. Pure App. Biosci.* **3** (5): 121-127.

[45] Ribas-Fito, N. E., Cardo, M., Sala, M. E., de Muga, C., Ma zon, A., Verdu, M., Kogevinas, O. J., Grimalt, J. Sunyer. (2003). "Breastfeeding, Exposure to Organochlorine Compounds and Neurodevelopment in Infants," *Pediatrics.* **111**(5): 580-585.

[46] Schettino, B., Gutiérrez, R., Ortiz, R., Vega, S., Urban, G. and Ramírez, A. (2013). Residues of legacy organochlorine contaminants in the milk of Alpine and Saanen goats from the central region of Mexico. *Bull Environ Contam Toxicol.* **91**(2):154-9.

[47] Sharma, H.R., Kaushik, A., and Kaushik, C.P. (2007). Pesticide residues in bovine milk from a predominantly agricultural state of Haryana, India. *Environ Monit Assess.* **129**(1-3):349-57.

[48] Singh, A.K., Sar, T.K. and Mandal, T.K. (2013). Monitoring of pesticide residue in bovine milk from Nadia district, West Bengal. *Bull Environ Contam Toxicol.* **91**(1):13-7.

[49] Tsakiris, I.N., Goumenou, M., Tzatzarakis, M.N., Alegakis, A.K., Tsitsimpikou, C., Ozcagli E., Vynias, D., and Tsatsakis, A.M. (2015). Risk assessment for children exposed to DDT residues in various milk types from the Greek market. *Food Chem Toxicol.* **75**:156-65.

[50] Wahab, A.A.D., Ragaa, M. A., El-Maaboud., Maha, A.H., Sohir, A.M., Waleed H.A. (2004). Detection of organochlorine pesticide residues in samples of cow milk collected from Sohag and qena governorates.*Ass. Uni. Bull. Environ. Res.* **7** (2): 105-115.

[51] Waliszewski, S.M., Pardio, V.T., Waliszewski, K.N., Chantiri, J.N., Aguirre, A.A., Infanzon, R.M., Rivera, J. (1997). Organochlorine Pesticide Residues in Cow's Milk and Butter in Mexico," *Sci of the Total Environ.*, **208** (1-2): 127-132.

[52] Waliszewski, S.M., Villalobos-Pietrini, R., Gomez-Arroyo, S. and Infanzon, R.M. (2003). Persistent organochlorine pesticide levels in cow's milk samples from tropical regions of Mexico. *Food Addit. Contam*. **20**:270–275.

[53] Witczak, A., Mituniewicz-Małek, A. and Dmytrów, I. (2013). Assessment of daily intake of organochlorine pesticides from milk in different regions of Poland. *J Environ Sci Health B.* **48**(2):83-91.

[54] Wong, M.H., Leung, A.O.W., Chan, J.K.Y. (2005). A review on the usage of POP pesticides in China, with emphasis on DDT loadings in human milk. *Chemos*. **60**: 740– 752.

[55] Wong, S.K. and Lee, W.O. (1997). Survey of organochlorine pesticide residues in milk in Hong Kong (1993– 1995). *JAOAC Int.* **80**:1332–1335.

[56] Zheng, G., Han, C., Liu, Y., Wang, J., Zhu, M., Wang, C.,and Shen, Y. (2014). Multi-residue analysis of 30 organochlorine pesticides in milk and milk powder by gel permeation chromatography-solid phase extraction-gas chromatography-tandem mass spectrometry. *J Dairy Sci*. **97**(10):6016-26.

[57] Zhong, W., Xu, D., Chai, Z., Mao, X. (2003). Survey of organochlorine pesticide in retail milk from Beijing, P.R. China. Food Addit *Contam.* **20:**254–258.