

## A Perspective on Organochlorine Pesticide Residues in Milk Produced in Pakistan

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### Abstract

Milk and milk products are known to have huge nutritional value with prevalent natural potential. Milk is a source of energy and it contains all required building proteins, bone forming minerals, fats etc. Milk is contaminated with pesticides such as Organochlorine pesticide (OCPs). Consumption of contaminated food, milk, meat, fish and dairy products is the cause of high level of OCPs in the body. Milk is a good source to dissolve pesticide residues such as OCPs which are fat soluble. These OCPs are incorporated in digestive tract especially absorbed by small intestine and become the part of circulatory system. Through circulation these are dispersed in whole body. By the regular exchange between blood and tissues they aggregate in the tissues which are high in lipid content. These OCPs have been recognized in body tissues such as blood tissues, adipose tissues. Pakistan's dairy industry has significant importance for the national economy of Pakistan and its worth is more than both of wheat and cotton combined. Milk production is approximately about 42.17 million tons of total Pakistan in top milk producers throughout the world. This review presents the status and scenario of OCPs in milk produced in Pakistan.

**Keywords:** Organochlorine Pesticide; Milk Products; Pakistan

### Introduction

Milk is considered as a complete food as it has an exceptional nutritional value. Milk and its products are known to have huge nutritional value with prevalent natural potential. Milk is a supreme source of nourishment generally utilized as a part of all age groups of the population in all phases of life [1]. Milk is the important part of all other animals related food products [2].

Milk can make a compelling improvement to the required supplement absorption for calcium, magnesium, selenium, riboflavin, vitamin B<sub>12</sub>. Milk and dairy products being animal-origin food can be significant source of zinc and vitamin B<sub>12</sub> in children with micronutrient deficiencies. Likewise, milk is thought to contain components that upgrade mineral retention, for example, lactose and certain amino acids [2].

According to Food and Agriculture Organization (FAO) milk provide an average 134 kcal of energy/capita per day and contribute 8 and 7.3 grams of protein and fat/capita per day, respectively. However, nutritional components differ remarkably as geographical area changes [2]. Generally, cows, buffaloes, goats, camel are the milk producing animals. However, cows and buffaloes are the large domesticated source of milk [3]. Buffalo milk contains comparatively higher concentration of total solids, fat, protein and lactose than cow milk [4]. Milk has great importance as a raw material for preparing dairy product. Homemade butter is especially important, which is used as alternate for oil in many countries [2].

### Milk production in Pakistan

The dairy industry has significant importance for the national economy of Pakistan and its worth is more than both of wheat and cotton combined. Milk production is approximately about 42.17 million tons of total Pakistan in top milk producers throughout the world. Buffalo and cow are top milk producing animals in Pakistan that contribute 62 percent and 34 percent milk production respectively [5]. Rural areas produce almost 80% milk with 15% milk is produced in peri-urban areas as well as 5% milk is produced in urban areas. Major milk producing provinces are Punjab and Sindh contributing yearly production with 25.62 million and 9.35 million liters respectively. Khyber Pakhtunkhwa produces 4.88 million liters and Baluchistan produces 0.81 million liters milk per year [6].

### What are pesticides?

Pesticides are substance that is used to destroy, suppress or alter the life cycle of pest. It can be derived naturally and can be produced synthetically. It can be a chemical or can be an organism like bactericides. These days more than 800 various types of pesticides are used. Insecticides, fungicides, rodenticides, herbicides etc. are utilized for control of insects, rodents, fungi and undesired plants in the process of agricultural production. Whereas the greater part of them leave remaining components or deteriorate in the soil, water and atmosphere. Many of these chemicals are also used by health department to control many insects that play role in transmission of many diseases like malaria, dengue fever and illness [4]. Also, pesticides play an important role in enhancing the quality of food stuff as well as its immunity [7, 8].

### Vulnerability of milk to Organochlorine pesticide (OCPs) Residues

All animal-origin food and its products acquired quick attention due it's both vital furthermore, supplementary nutritional worth. As milk contains substantial amount of fat, hence the presence of these lipophilic compound in milk is farther from any uncertainty [6]. Inappropriate dirt, environment and polluted water may be the sole reason for milk contamination. The possibilities through which milk can contaminate with pesticides include 1): presence of elevated level of pesticide residues in food which have been treated after harvesting, 2): food produced by plant material which have been treated with pesticides during growth period, 3): use of insecticides for the control of disease causing agents, vectors, flies etc, 4): hygienic treatment in milk processing factories to control insects. The contamination of milk depends upon the nature of compound, its strength, method of application and the time period for ingestion as well as exposure [1]. After ingestion, lipophilic pesticides get assimilated from the digestive system into the general body circulation. Being lipid soluble pesticides accumulate in tissues rich in lipid contents including adipose tissue, brain, liver, and kidney as well as in milk [9]. Several authors in different countries have been reporting milk contamination with pesticides for the last few decades [6].

### Health implications of OCPs

In spite of the fact that pesticides are used through extremely strict regulation procedures to work with sensible sureness and negligible effect on human health as well as on environment [10]. The abuse of pesticides has resulted in economic loss as well as danger to human health and pesticides exposure can be determined by the amount of pesticides residues left in an environment [11-15]. Many serious health issues have been arising because of pesticides exposure to the farmers who work in open fields regularly, workers in pesticides industry, eliminators for house pests, and residues in food and drinking water [10]. Organochlorine pesticide residues degrade slowly in environment because of this property organochlorine pesticide residues enter in the food chain. The consumption of this contaminated food like meat, milk, fish and dairy products is the cause of elevated level of OCPs in body. For instance, OCPs can persist in the body up to 50 years [16].

OCPs are incorporated in digestive tract especially absorbed by small intestine and become the part of circulatory system. Through circulation these are dispersed in whole body. By the regular exchange between blood and tissues they aggregate in the tissues which are high in lipid content. These OCPs have been recognized in body tissues such as blood tissues, adipose tissues.

These OCPs are the main cause of various health issues like cancer, reproductive defects and also behavioural changes. These OCPs have the ability to disturb the functioning of some hormones, growth factors, neurotransmitter and enzymes [19].

### Use of Organochlorine pesticides in Pakistan

Likewise, other developing countries with poor institutional growth as well as slow financial development, leads to unhealthy agrochemicals such as pesticides in human diet. The agrochemicals like pesticides enter in our body by means of lipid rich food of animal origin. As livestock is significant and developing business in Pakistan [20,21]. Numerous studies have demonstrated that the major cause of more than 90 % of human intake of organochlorine compounds and other contaminants is animal-origin food [22,23].

Pakistan is an agro-based economy in which major contribution of GDP is based on cash crop like rice, cotton, sugarcane etc. Almost 70% population of Pakistan is related to the field of agriculture and round about 68% industrial business is linked with agriculture. Pakistan has favourable conditions for a wide range of crops. To fulfil the increasing demand of food the use of pesticides has been increased for the last few years. Cotton is an important cash crop of Pakistan and being a significant export product there is need to improve the quality and quantity of cotton crop [24]. A large amount of pesticides was applied to cotton crop almost 80% of total pesticides [25]. When cotton is plucked then remaining stems of plant body are used as animal fodder and also used in preparing animal feed like "vadda". Because of the treatment with pesticides, the fodder prepared by this plant is contaminated with OCPs. When we use fodder for milk producing animals these OCPs also contaminate milk [26].

### Pesticides implication

Approximately only 0.1% pesticides achieve their goals by targeting specific pest while rest of the pesticides proportion pollutes abiotic components of environment [27].

Unluckily, environmental application of these pesticides and effects of pesticides on living and non-living components of ecosystem is noticed by the scientist after few years almost after 20 years when a well-known book "Silent spring" on DDT usage by Rachel Carson is published. She disclosed the effects of pesticides like thinning of egg shell which results in death of birds. Scientist took advantage of this book and started to examine the environmental conditions after use of pesticides.

US have banned the use of mostly OCPs in account for persistency and bioaccumulation in the living and non-living bodies of an ecosystem. A lot of studies had been conducted on aggregation of pesticides more specifically on OCPs in water, soil and food [28-32].

Organochlorine and organophosphorus pesticides are mostly used as compared to other pesticides. Organochlorine pesticides are less biodegradable that's why these pesticides remain in an environment after long time of application and can enter into food chain [33]. However, organophosphorus pesticides are biodegradable, but it depends upon the application procedures, formation, atmospheric conditions and developmental stage of plant body [33].

### Persistence of OCPs

Soil is contaminated with organochlorine pesticides while application, runoff from plants, when disposed of and incorporation of these pesticide residues with soil particles [34]. But because of slow degradation these pesticide residues can enter into human bodies due to leaching and through translocation between living organisms [27]. Use of pesticide as a fertilizer, cutting down the forest which results in soil erosion, household waste material, chemical effluents are some of the causes of soil contamination [27].

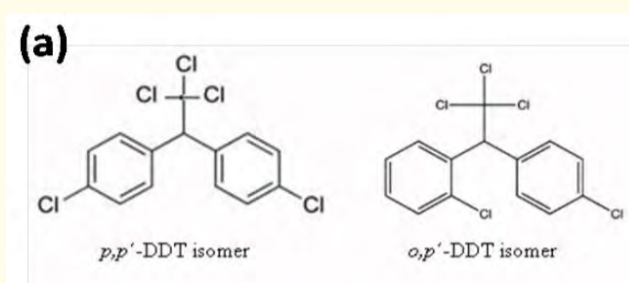
### Organochlorine Pesticides

Production cost of the agriculture can be raised if effective pesticides are not utilized. These pesticides are used for pest management

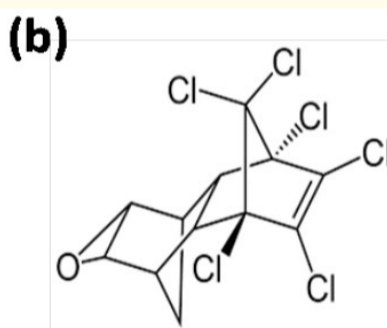
on crops [35]. Pesticides despite of ban are utilized in some countries or they have their hazardous effects in soil or sediments due to lipophilic properties [36]. Chlorinated compounds containing hydrogen and carbon are called organochlorine compounds. Since 1970, many developing countries have been banned OCPs because of their poisonous nature and the ability of being incorporated in living body. Also, remnants of OCPs have been found in soil [37,38].

Different organochlorine compounds have different chemical structure [36]. There are different types of Organochlorine Pesticides (OCPs) which can be classified in to four classes I.e.; diphenylaliphatic, cycloidians, chlorinated benzenes and cyclohexane's.

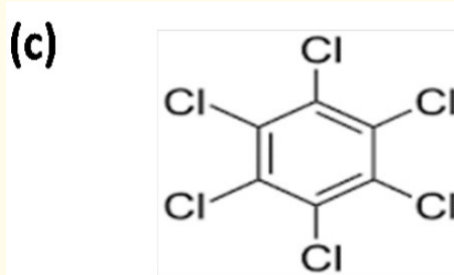
DDT was originally developed in 1939 as modern insecticide to combat diseases like malaria and typhus etc. It was developed by Paul Muller. Physical characteristics include white color, crystalline shape, odorless solid and mixture of isomers [42]. DDT has lipophilic properties, so it can be store in fatty tissues of animals and birds as well. It is chemically toxic and can prevail in environment for long term due to its properties. It can persist in soil but cannot reach water [42]. The major metabolites of DDT are Dichloride phenylethane (DDE) and Dichlorodiphenyldichloroethane (DDD) and they are formed as a result of breakdown of DDT [39] (Figure 1-a).



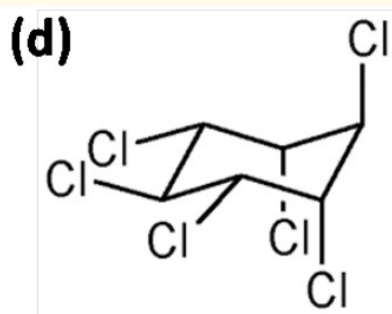
Dieldrin was derived as alternative to DDT in 1950. It is highly effective insecticide. It is hydrophobic and can adhere to soil particle. It is categorized as persistent pollutant which can prevail in environment for long time. It breakdown in soil gradually and also become the part of soil and hence enter in human body. It also has lipophilic property [38] (Figure 1-b).



Benzene hexachloride (BHC), any of a few stereoisomers of 1, 2, 3, 4, 5, 6 - hexachlorocyclohexane shaped by the light-impelled expansion of chlorine to benzene. One of these isomers is a bug spray called lindane, or Gamma hexane [40]. Benzene hexachloride was initially developed in 1825; the insecticidal properties were recognized in 1944 with the  $\gamma$  - isomer (gamma-isomer), which is around 1,000 times more poisonous than any of alternate diastereomers shaped in the response [40] (Figure 1-c).

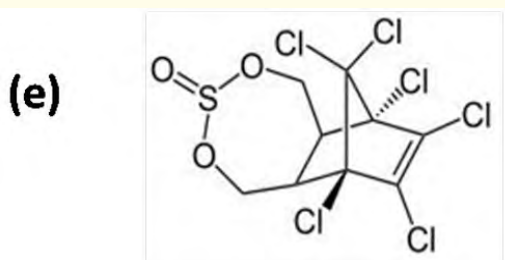


Lindane is also known as gamma hexachlorocyclohexane or Gammalline. It is used as insecticide in agriculture and in also in pharmaceutical for treatment of scabies like diseases. It was discovered in 1825 by Faraday. It is persistent organic pollutant and long lived in environment. When it is used in agriculture it become volatile 12 - 30 percent and with rain fall deposit in soil. It can reach surface, ground water and part of food chain [41] (Figure 1-d).



Endosulphan is used to control pests in fruits, vegetables, cotton, cereal grains as well as in ornamental plant. Likewise, it is also used to control ectoparasite in some animals like cattle. Endosulphan is toxic and act as a endocrine disrupter in human and animals [42].

Commercial Endosulphan is a mixture of stereo isomers,  $\alpha$ -Endosulphan,  $\beta$ -Endosulphan, Endosulphan sulphate and some other compounds. Endosulphan sulphate is derived from Endosulphan. The average half-life of Endosulphan and Endosulphan sulphate is roughly 9 months to 6 years depending upon the environmental conditions. Endosulphan is the cause of convulsions, hyperactivity, nausea, tremor, lack of coordination in severe cases [43] (Figure 1-e).



**Figure 1:** Structure of OCPs. (a) DDT, DDE, (b) Dieldrin (c) HCH, (d) Lindane, (e) Endosulphan.

### Use of organochlorine in Pakistan

Pakistan is not organochlorine pesticide manufacturer. Hence, these pesticides are imported to fulfill the need of pesticides [44].

Pakistan is a signatory of Stockholm convention which is held in 2001, but still there is a lack of controlling mechanism the use of OCPs level in environment [44]. In the NEQS (National Environmental Quality Standard) list these chemicals are not included as concerned priority chemicals. Pakistan has largest stocks of expired pesticides throughout the world resulting in severe environmental pollution in warehouses in different parts of country [44,45].

Organochlorine compounds are lipophilic and less metabolized in living organisms [46]. Food contaminated by organochlorine pesticides including fat-rich dairy products like butter, cheese etc causing exposure of user to these chemicals [47].

Because of low in cost, longer half-life and variety against many pest's organochlorine is one of the most preferred pesticides among the communities related to the field of agriculture in many developing nations like India [48].

Milk has been considered as a factor that can indicate the bio-concentration of micro-pollutants such as pesticides [49]. Milk is a good source to dissolve pesticide residues such as organochlorine which are fat soluble [50]. There are many ways by which milk can get contaminated with pesticide residues in food stuff harvested previously, food manufactured by the plants treated by insecticides, usage of insecticides on animals for disease control, insecticides spray on animal stables, and finally factory processing of milk to make it hygienic [1].

Different studies have been conducting this research. One of the study results show that there was contamination milk sample leading to the human health. This is dangerous as the biochemical residues entered in human body although in very small quantity, but their bio accumulation property can lead to disastrous health risks [51].

One study found that there was presence of pesticide residues in milk. Source of this contamination was environmental. Animals whose milk was contaminated were exposed to dust containing pesticides particles and so as air inhaled by animals. The presence of these residues in milk was due to the persistence in cattle body and moreover they were non-degradable having lipophilic properties [47].

Another study shows that there was OCP presence in cow and pasteurized milk in sample collected because animal live in domestic environment where exposure to OCP is always there which hence moved in milk [51].

One research detected pesticides residues in milk samples collected from local vendors, shop and dairy forms of the relevant target area. Several OCPs found out which Lindane and Malathion exceeded MRL limit. This contaminated milk was dangerous for human health, so they advised to run monitoring program to control the OCPs level in milk [52].

A study concluded that DDT was higher than HCH in milk. They found traces of OCPs in milk and other dairy products. They analysed although level of OCPs in milk and dairy products were lower than tolerance limit but if not controlled can increase more than tolerance limit. Moreover, this presence also exposed to human health [53].

Another study also found OCPs in dairy products after analysis of samples. They found in OCPs analysis that few of the pesticides were exceeding in daily intake limit for cattle. They were of the view that continuous monitoring is required to reduce and maintain OCPs in dairy products by monitored dietary intake of animals [54]. A study has determined that feeding contaminated food and water to the animals plays a role of source of organochlorine pesticide residues in milk [55].

### Conclusion

It can be concluded that proper monitoring and evaluation, assessment, distribution trends, source identification and ecotoxicological effects on organisms regarding OCPs are needed to reduce health risks in Pakistan.

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