A Review on the Concentration of the Pesticides in Milk, Dairy Products, Vegetables and Fruits

O.P. Bansal
Chemistry Department, D.S. College, Aligarh, India

Abstract: Pesticides from decades are used not only in the agricultural fields for the increase in food production but also for public health protection. More than 1000 different organic and inorganic compounds are used as pesticides. Most widely used pesticides are organochlorine pesticides, which are not only toxic but persist in the environment for decades and are bioaccumulated. Uncontrolled use of pesticides, their persistence results in the pesticide residues or related daughter products in the soil, surface water, groundwater, air, and in primary and derived agricultural products. Due to consumption of pesticides contaminated rations and use of the pesticides on the animals to control ectoparasites, application of pesticides on fruits and vegetables to control pests lead to the presence of pesticides in milk, vegetables, and fruits. For the survival of any humankind milk, vegetables, and fruits play a very important role as they are the sources of vitamins, carbohydrates, essential trace metals, antioxidants. The accumulation of the pesticides in food products adversely affects human health ranging from short term to long-term impacts. Headaches, nausea, asthma, sore throat, eye irritation, skin irritation, diarrhoea, pharyngitis, nasal irritation, sinusitis, contact dermatitis, inflammation, endocrine disruption are some short-term effects of pesticides to human, while long term exposure may cause birth defects, infertility, endocrine disruption, depression, diabetes, neurological deficits besides cancer. This review aims to report the concentration of the commonly used pesticides in animal milk, human milk, fruits, vegetables, grains and their impact on human.

Keywords: Pesticides, Human, Environment, Milk, Fruits, Vegetables, Animals

INTRODUCTION

To feed ever-growing human population which is expected to be 9.7 billion by 2050 (UN, 2015) will require more agricultural production, especially in tropical regions. Since the green revolution of the 60s the use of pesticides in agriculture to protect plants from pests, plant regulators, desiccant, in public health protection to protect humans from vector-borne diseases like malaria, dengue fever has been increased many folds. As per estimation the global annual consumption of the pesticides is approximately 3.5 million tonnes (Steingrímsdóttir et al., 2018) and is increasing by 4% annually. An application of pesticides improves the crop quality and soil health by controlling pests and plant diseases, controls pests like termites, cockroach harmful to human activities and structure. To provide off-season vegetables and fruits to the nation in more temperate weathers the use of the pesticides by developing countries became useful for the economy of the developing countries. About 95% of the applied pesticides affect non-targeted species, air, soil, and water. Since 1970 pesticides and their metabolites have been found in all the compartments of the environment, viz., air, groundwater, surface water, food chain, etc.

As the Milk, a white fluid produced by the mammary glands of the mammals (cow, buffalo, goat, sheep, and human), contains essential nutrient proteins, amino acids, vitamins, lactose, minerals, essential fatty acids, immunoglobulins, antimicrobial in the balanced ratio is the main source of nutrition for young mammals till other types of food is not digested by them and an important component of the diet of elders (Kowalska et al., 2020; Sarsembayeva et al., 2020). The amount and the ratio of these nutrients in the milk vary with the animal species and breeds within the species. In 2018 the global turnover of the milk and dairy industries was estimated to be about 442 billion US dollars and expected to grow by 5.2% annually. As per estimate the worldwide milk consumption in 2017 was 216 million metric tons and is expected to become 234 million metric tons in 2021. As per estimation, the average annual global consumption of the milk in the year 2018 was 100 kg/person.

Majority of widely applied organochlorine pesticides viz, DDT, HCH are stable and persist in the environment for decades, resulting in the pesticide residues or related daughter products found in the soil,
surface water, groundwater, air, and crop yields (Pan et al., 2019; Bai et al., 2018). The residues of pesticides have also been reported in animal milk, human breast milk samples, fruits, vegetables, cereals, grains, animal feeds by the number of food scientists (Blaznik et al., 2016; Del Prado Lu, 2015; Chourasiya et al., 2014; Witczak & Abdel-Gawad, 2014).

The present review throws light on the concentration of the pesticides in milk samples and the vegetables and fruits commonly consumed by humans.

Types of Commonly used Pesticides
Based on their structure commonly used pesticides are classified into following;

Organochlorine pesticides
Organochlorine pesticides are those pesticides which have cycloide ring with five or more chlorine atoms and is the first synthetic pesticide group. The organochlorine pesticides are widely used in a agricultural field and for public health purposes to control vector-borne diseases. DDT, HCH, aldrin, dieldrin, endosulfan, heptachlor, dicofol, chlordane, and methoxychlor are some commonly used organochlorines pesticides. Due to the overuse of DDT, it is believed that DDT is present in the body of every living organism on Earth, stored in the fat.

Organophosphorus pesticides
Organophosphorus pesticides are broad spectrum biodegradable pesticides, were promoted as a more ecological alternative of persistent organochlorine pesticides were first synthesized in 1937 from phosphoric acid. Due to their polar nature, most of the organophosphorus pesticides are water-soluble. Organophosphorus pesticides can be classified into three groups: aliphatics (e.g., malathion), aromatics (e.g., parathion), and heterocyclics (e.g., phosalone).

Expect aromatic and sulphurous derivatives all the other organophosphorus pesticides are easily degraded in the environment. Some commonly used organophosphorus pesticides are Parathion, Malathion, Diazinon, dimethoate, chlorpyrifos, dichlorvos, and fenthion and glyphosphate.

Carbamate and Dithiocarbamate pesticides
Carbamate pesticides are the broad spectrum easily degradable pesticides and more effective against those pests which attain immunity against organochlorine and organophosphorus pesticides. These pesticides have the chemical structure R-O-CO-N-CH (sub)-3 R’ (where R is alcohol, oxime or phenol and R’ is ether, H or alkyl group). Dimetan was the first synthetic carbamate pesticide. These pesticides are used as the stomach, contact poison and fumigant. Most of the carbamate pesticides are less volatile and fat-soluble. Commonly used carbamate pesticides are carbaryl, oxamyl, carbofuran, aminocarb, aldicarb, and propoxur. Dithiocarbimate pesticides have the chemical structure (R, R’) N-(C=S)-SX, where R, R’ can be an alkyl, alkenyl, aryl, or similar other groups, and X a metal ion.

Based on the metal cation present the dithiocarbamate pesticides are classified into two groups (i) dimethyl dithiocarbamate and (ii) ethylenebisdithiocarbamate. These pesticides were introduced after World War II. Commonly used dithiocarbamate pesticides are Thiram, disulfiram, ziram, and ferbam.

Pyrethrins and pyrethroids pesticides
Pyrethrins are the natural compounds, having active pesticidal agents’ pyrethrins got from the plant Chrysanthemum cineraria folium while pyrethroids are synthetic non-persistent pesticides. Most of the pyrethrins and pyrethroids pesticides are water-insoluble and fat-soluble and are less toxic to mammals. Both pyrethrins and pyrethroid pesticides exist in cis and Trans forms and carry a central ester bond and are the esters of 3-phenoxy phenyl alcohol. The pyrethroids are based on cyano radical is classified into two groups, Type I- which contain no cyano radical viz, permethrin, tetramethrin and Type II- containing cyano radical viz.,Deltamethrin, fenvalerate. These pesticides affect the muscular system of pest and affect the sodium channel in the target.

Sources of pesticides within the environment
During and after World War II to increase food production and to develop chemical warfare agents the development and production of pesticides have increased. With the green revolution of the 60s the use of pesticides in the agriculture sector to protect plants from pests has been increased many folds. In the agriculture sector pesticides are second to fertilizers in the use. The pesticides can enter the atmosphere because of (i) volatilization from the soil; plant leaves (ii) evaporation from surface water (iii) drifting and losses during application (iv)wind erosion.

The main sources of environmental contamination by the pesticides are
The pesticides are mainly used in the agriculture and in public health protection to protect plants from pests, weeds and other diseases and humans from vector-borne diseases such as malaria, dengue fever. Some pesticides are also used in sport fields, urban green areas, building materials, in some lice removal shampoos, pet shampoos, and in coatings of the bottom of the boats. Environmental contamination by the pesticides also occurs by leaks and spill from the storage sites, spilling during loading into the application equipment, rinsing containers, improper disposal of containers containing pesticides.

Routes of Contamination
Routes of contamination of Milk:
The main routes of contamination of the milk by the pesticides are:
Uptake of the pesticides by the animals
Routes of uptake of the pesticides by the animals are (Ishaq et al., 2018):
(i) Ingestion: It occurs via gastrointestinal route i.e. by up-taking contaminated green fodder, drinking water, veterinary medicines and other feeds via the mouth.
(ii) Dermal: Dermal uptake means absorption through the skin.
(iii) Inhalation: Inhalation uptake occurs via inhalation of the polluted air as dust fumes or contaminated vapours.

Other Sources of contamination
Spray of pesticides in animal production places (and/or treatment of animals themselves).

Routes of contamination of fruits, vegetables etc
The major route of accumulation of the pesticides in fruits, vegetables is via absorption by the plants with water and minerals from soils. Plants absorb the pesticides which are washed in soil or water bodies applied on crop plants for the protection from the pests. As the pesticides are not easily decomposing their biomagnifications occurs.

Pesticides in the milk
Milk quality and the composition depends on the cattle, its breed, diet provided, the chemical composition of the soil of the area, the quality of drinking water, and the water used for irrigation of the crops. The milk is contaminated by chlorinated pesticides, organophosphates, carbamates, antihelminthic drugs, antibiotic, potentially toxic metals, etc. The residue of the pesticides and their metabolites in the milk is due to contamination of water, consumption of contaminated rations and use of the pesticides on the animals to control ectoparasites. About 20% of the ingested chlorinated organic compounds are present in the milk (Jayaraj et al., 2016). It is estimated that 90% of the average human intake of organochlorine compounds is via animal-origin food. A review of literature denote that 75-85% of the animal milk samples are contaminated with organochlorine and/or organophosphorus pesticides and more than 60% of the samples are contaminated with two or more than two types of pesticides. The concentration of these pesticides in buffalo, cow milk, and human milk is recorded in the Table1.

Pesticides in vegetables and fruits
Excessive use of the pesticides, the water solubility of pesticides, improper irrigation, and rainfall causes the leaching of pesticides in the groundwater (Rai & Pandey, 2017). Globally in more than 50% of the groundwater, the concentration of the pesticides is in excess than the permissible limits. Long-term studies (11 years) made by Bansal (2008) revealed that pesticides 2, 4-D, HCH, DDT, parathion are present in the groundwater of Aligarh city. As the groundwater, sewage water is used for irrigation the pesticides are bioaccumulated in the vegetables and fruits. Pesticides Cypermethrin, Chlorpyrifos, and imidacloprid were detected in the 65-70% of the Pumpkin, okra, eggplant; cucumber spinach and cabbage vegetables collected from Lahore city market (Munawar & Hameed, 2013). About 38% of fruit samples and 16% of vegetables grown in Poland were contaminated with more than one pesticide beyond the permissible limit was the findings of Szpyrka et al., (2015). In Africa, 91% of fruit and vegetable sample contains pesticides residues or their metabolites beyond the maximum permissible limit were the conclusion of Mutengwe et al., (2016). Mahmud et al., (2015) found that in most of the samples of vegetables, cocoa beans, and watermelon grown in Nigeria, the concentration of organophosphorus pesticides was beyond the permissible limit. Carbamate pesticides were beyond permissible limit in the 50% samples of vegetables grown in Bangladesh was the findings of Chowdhury et al., (2014). Park (2018) during their studies found that the 70% of conventionally grown fruits and vegetables are contaminated with pesticides and/or their metabolites and 98% of studied samples of peaches, cherries, and apples contain at least one pesticide. They also reported that the few samples of strawberries contain up to 20 different pesticides. The USA Environmental Working Group led by Meyer (2019) during their studies found that in more than 90% of samples of strawberries, apples, cherries, spinach, nectarines, and kale two or more pesticides are present, while in 50% of samples were tested positive for multiple pesticides. Several samples of kale are contaminated with a maximum of 18 pesticides. Fatunsin et al., (2020) during their studies found that organophosphate and carbamate pesticides residues are in food grown in Nigeria but their concentration was below the permissible limit. The concentration of the pesticides in vegetables, fruits, grains are grown globally are summarized in the Table1.

Impacts of pesticides on Human
Headaches, nausea, asthma, sore throat, eye irritation, skin irritation, diarrhoea, pharyngitis, nasal irritation, sinusitis, contact dermatitis, inflammation, endocrine disruption causing an exacerbation of asthma are some short term effects on human (Bourguet & Guillemaud, 2017; Amr et al., 2015) while birth defects, infertility, endocrine disruption, depression, diabetes, neurological deficits besides cancer are caused when humans are exposed to pesticides for a long period (Mostafalou & Abdollahi, 2013). As per WHO report(2018) globally about three million serious poisonings and 220,000 deaths each year are due to acute exposure of the pesticides, and the major route of exposure is food (90%).

Effects of organochlorine Pesticides
DDT (2, 2Dichlorodiphenyl 1, 1, trichloroethane) is the most widely known organochlorine
pesticide. DDT and its metabolites cause hyperplasia; myeloma; hypothyroidism; neurological and immunodeficiency disorder; brain, pancreatic, breast, prostate cancer; inhibition of the activity of Acetylcholinesterase enzyme, and, lipid metabolism, endocrine disruption; fibroids; Liver and blood in the human body are most affected parts (Bourguet & Guillemaud, 2017; Amr et al., 2015; Mostafalou & Abdollahi, 2013; Murtiyan & Mittal, 2013; Khanna & Gupta, 2016; Shrivatava et al., 2015; Koutros et al., 2015;Trabert et al., 2015). Lindane in the human body affects the central nervous system; endocrine system; reproductive system and causes neurotoxicity; breast, prostate, testicular, ovarian, kidney cancer; aplastic anaemia; nausea, headache and loss of consciousness; provoke seizures (Amr et al., 2015; Jaacks & Staimez, 2015; Lal, 2018; NTP, 2011; Croom et al., 2015). Hexachlorocyclohexane (HCH) is associated with Seizures, anaemia, cancer, endocrine disrupter, increase in blood pressure, and total cholesterol, diabetes; induction of hypospadias by affecting liver, kidney, blood, endocrine system (Khanna & Gupta, 2016; Shrivatava et al., 2015; Jaacks & Staimez, 2015; Lal, 2018; Lyche et al., 2016). Aldrin and dieldrin damages kidney and nervous system and in human causes headache; diarrhoea; nausea; convulsions and disruption in the central nervous system (Sharma et al., 2017; Najam & Alam, 2014).

Effects of organophosphorus pesticides

Organophosphorus pesticides also have carcinogenic, mutagenic, and teratogenic effects and their exposure to human cause cardiovascular diseases, seizures, respiratory depression, dementia, Leukaemia, Lymphoma, a neurological disorder in children, increased risk for non-Hodgkin's lymphoma, and Parkinson's and Alzheimer's diseases. Prolonged exposure to organophosphates affects the male reproductive system by the reduction of sperm activities, by damaging sperm DNA (Mehrpour et al., 2014), decreases gestational duration. Hypospadias is also induced by exposure to organophosphates and organochlorine (Lal, 2018; Michalakis et al., 2014) pesticides. Organophosphate pesticides affect the function of cholinesterase enzymes, decreases insulin secretion, disrupts cellular metabolism of carbohydrates, and fats. Organophosphorus pesticides also influence mitochondrial function, causes cellular oxidative stress and disruption to the normal nervous and endocrine functioning.

**Effects of Carbamate Pesticides**

Carbamate pesticides in human disrupt mitochondrial function, endocrine activity, cellular metabolic mechanisms, causes neurobehavioral effects, reproductive disorders by cytotoxic and genotoxic effects in ovarian cells, induces apoptosis and necrosis in human immune cells, and in T lymphocytes, enhances the chances of the development of non-Hodgkin's lymphoma, and risk of dementia (Mnin et al., 2011; Soloneski et al., 2015; Li et al., 2015).

**Other Classes of Chemical Pesticides**

Pyrethroids the safer pesticides also disrupt the endocrine activity, damages DNA in human sperm, develop neurotoxicity, and affects reproductive behaviour (Pandey & Mohanty, 2014; Syed et al., 2015). Triazines in human enhance breast cancer incidence and are associated with oxidative stress, cytotoxicity, and dopaminergic effects. These pesticides also delay sexual maturation in humans (Li et al., 2015; Ma et al., 2015; Jin et al., 2014).

**Table 1:** The concentration of pesticides in Milk, Vegetables, Fruits, Grains, and Green fodder

| S N | Pesticide | Buffalo milk | Cow milk | Sheep/Goat milk | Pasteurized Milk | Human milk | Fruits | Vegetables | Grains | Green fodder |
|-----|-----------|--------------|----------|----------------|------------------|------------|--------|------------|--------|--------------|
| 1   | Alachlor  | 0.000-0.001  |          |                |                  |            |        |            |        |              |
|     |           | mg/kg        | (Shaker & Elsharkawy, 2015) | | | | | | | |
| 2   | BHC/ HCH  | 0.022-0.049  | 0.009-0.262 | 0.45-2.34 ug/kg | 90ug/kg | Watermelon | 0.0-11.3ug/kg | Maize-2.19ug/kg | (Kolani et al., 2016); (Oyeyiola et al., 2017); |
|     |           | mg/kg        | (Akhtar & Ahad, 2017); | (Avancini et al., 2013); | (Elsero et al., 2013); | | | | |
|     |           | mg/kg | (Rusu et al., 2017); fat | ugy et al., 2013); | (Koranteng et al., 2017); | | | | |
|     |           |           | 31.89 ug/kg | 0.0-60ug/kg | 0-2.389 | 19.03ug/kg | | | |

© East African Scholars Publisher, Kenya
| Compound       | 0.0069-0.170 mg/kg fat (Witczak et al., 2018) | 0.015 mg/kg fat (Aytenfsu et al., 2016) | 0.0069-0.170 mg/kg dw (Raslan et al., 2016) | 1.32 ug/L (Bulut et al., 2011) | 0.1-10.18 ug/kg (Ishaq & Nawaz, 2018) | 0.0-61 mg/kg fat (Kiranma yi et al., 2018) | 0.0-67 ug/kg (Gill et al., 2020) | 0.094 mg/kg fat (Aytenfsu et al., 2016) | 113.7 ug/kg dw (Raslan et al., 2018) | 3.57 ug/kg (Abbassy, 2017) |
|---------------|-----------------------------------------------|----------------------------------------|-----------------------------------------------|--------------------------------|------------------------------------------|------------------------------------------|---------------------------------|--------------------------------|--------------------------------|-------------------------|
| (Witczak et al., 2016) dw | (Raslan et al., 2016) | (Bergkvist et al., 2012) | (Haque et al., 2017) | (Ntow, 2001) | (Elbashi r et al., 2015) | (Abbassy et al., 2017) | (Farina et al., 2016) | (Kolani et al., 2016) | (Bolor et al., 2018) | (Chen et al., 2018) |
| 0.0069-0.170 mg/kg fat (Witczak et al., 2018) | 0.015 mg/kg fat (Aytenfsu et al., 2016) | 1.32 ug/L (Bulut et al., 2011) | 0.1-10.18 ug/kg (Ishaq & Nawaz, 2018) | 0.0-61 mg/kg fat (Kiranma yi et al., 2018) | 0.0-67 ug/kg (Gill et al., 2020) | 0.094 mg/kg fat (Aytenfsu et al., 2016) | 113.7 ug/kg dw (Raslan et al., 2018) | 3.57 ug/kg (Abbassy, 2017) | 1.02-0.52 mg/L (Shahzadi et al., 2018) | 0.13-0.73 mg/L (Shahzadi et al., 2018) |
| 1.32 ug/L (Bulut et al., 2018) | 0.015 mg/kg fat (Aytenfsu et al., 2016) | 0.1-10.18 ug/kg (Ishaq & Nawaz, 2018) | 0.0-61 mg/kg fat (Kiranma yi et al., 2018) | 0.0-67 ug/kg (Gill et al., 2020) | 0.094 mg/kg fat (Aytenfsu et al., 2016) | 113.7 ug/kg dw (Raslan et al., 2018) | 3.57 ug/kg (Abbassy, 2017) | 0.02-0.52 mg/L (Shahzadi et al., 2018) | 0.13-0.73 mg/L (Shahzadi et al., 2018) | 0.09-0.74 mg/L (Shahzadi et al., 2018) |
| 0.015 mg/kg fat (Aytenfsu et al., 2016) | 1.32 ug/L (Bulut et al., 2011) | 0.1-10.18 ug/kg (Ishaq & Nawaz, 2018) | 0.0-61 mg/kg fat (Kiranma yi et al., 2018) | 0.0-67 ug/kg (Gill et al., 2020) | 0.094 mg/kg fat (Aytenfsu et al., 2016) | 113.7 ug/kg dw (Raslan et al., 2018) | 3.57 ug/kg (Abbassy, 2017) | 0.02-0.52 mg/L (Shahzadi et al., 2018) | 0.13-0.73 mg/L (Shahzadi et al., 2018) | 0.09-0.74 mg/L (Shahzadi et al., 2018) |
| 1.32 ug/L (Bulut et al., 2018) | 0.015 mg/kg fat (Aytenfsu et al., 2016) | 0.1-10.18 ug/kg (Ishaq & Nawaz, 2018) | 0.0-61 mg/kg fat (Kiranma yi et al., 2018) | 0.0-67 ug/kg (Gill et al., 2020) | 0.094 mg/kg fat (Aytenfsu et al., 2016) | 113.7 ug/kg dw (Raslan et al., 2018) | 3.57 ug/kg (Abbassy, 2017) | 0.02-0.52 mg/L (Shahzadi et al., 2018) | 0.13-0.73 mg/L (Shahzadi et al., 2018) | 0.09-0.74 mg/L (Shahzadi et al., 2018) |
| 0.015 mg/kg fat (Aytenfsu et al., 2016) | 1.32 ug/L (Bulut et al., 2011) | 0.1-10.18 ug/kg (Ishaq & Nawaz, 2018) | 0.0-61 mg/kg fat (Kiranma yi et al., 2018) | 0.0-67 ug/kg (Gill et al., 2020) | 0.094 mg/kg fat (Aytenfsu et al., 2016) | 113.7 ug/kg dw (Raslan et al., 2018) | 3.57 ug/kg (Abbassy, 2017) | 0.02-0.52 mg/L (Shahzadi et al., 2018) | 0.13-0.73 mg/L (Shahzadi et al., 2018) | 0.09-0.74 mg/L (Shahzadi et al., 2018) |
| 0.015 mg/kg fat (Aytenfsu et al., 2016) | 1.32 ug/L (Bulut et al., 2011) | 0.1-10.18 ug/kg (Ishaq & Nawaz, 2018) | 0.0-61 mg/kg fat (Kiranma yi et al., 2018) | 0.0-67 ug/kg (Gill et al., 2020) | 0.094 mg/kg fat (Aytenfsu et al., 2016) | 113.7 ug/kg dw (Raslan et al., 2018) | 3.57 ug/kg (Abbassy, 2017) | 0.02-0.52 mg/L (Shahzadi et al., 2018) | 0.13-0.73 mg/L (Shahzadi et al., 2018) | 0.09-0.74 mg/L (Shahzadi et al., 2018) |
| 0.015 mg/kg fat (Aytenfsu et al., 2016) | 1.32 ug/L (Bulut et al., 2011) | 0.1-10.18 ug/kg (Ishaq & Nawaz, 2018) | 0.0-61 mg/kg fat (Kiranma yi et al., 2018) | 0.0-67 ug/kg (Gill et al., 2020) | 0.094 mg/kg fat (Aytenfsu et al., 2016) | 113.7 ug/kg dw (Raslan et al., 2018) | 3.57 ug/kg (Abbassy, 2017) | 0.02-0.52 mg/L (Shahzadi et al., 2018) | 0.13-0.73 mg/L (Shahzadi et al., 2018) | 0.09-0.74 mg/L (Shahzadi et al., 2018) |
| 0.015 mg/kg fat (Aytenfsu et al., 2016) | 1.32 ug/L (Bulut et al., 2011) | 0.1-10.18 ug/kg (Ishaq & Nawaz, 2018) | 0.0-61 mg/kg fat (Kiranma yi et al., 2018) | 0.0-67 ug/kg (Gill et al., 2020) | 0.094 mg/kg fat (Aytenfsu et al., 2016) | 113.7 ug/kg dw (Raslan et al., 2018) | 3.57 ug/kg (Abbassy, 2017) | 0.02-0.52 mg/L (Shahzadi et al., 2018) | 0.13-0.73 mg/L (Shahzadi et al., 2018) | 0.09-0.74 mg/L (Shahzadi et al., 2018) |
| 0.015 mg/kg fat (Aytenfsu et al., 2016) | 1.32 ug/L (Bulut et al., 2011) | 0.1-10.18 ug/kg (Ishaq & Nawaz, 2018) | 0.0-61 mg/kg fat (Kiranma yi et al., 2018) | 0.0-67 ug/kg (Gill et al., 2020) | 0.094 mg/kg fat (Aytenfsu et al., 2016) | 113.7 ug/kg dw (Raslan et al., 2018) | 3.57 ug/kg (Abbassy, 2017) | 0.02-0.52 mg/L (Shahzadi et al., 2018) | 0.13-0.73 mg/L (Shahzadi et al., 2018) | 0.09-0.74 mg/L (Shahzadi et al., 2018) |

© East African Scholars Publisher, Kenya
| Ingredient             | Range/Mass (Unit) | Source                                                                 |
|-----------------------|-------------------|------------------------------------------------------------------------|
| Watermelon            | 0.06 mg/kg        | (Qamar et al., 2017)                                                   |
| Round Gourd           | 3.87 mg/kg        | (Akhtar et al., 2018); Salad                                           |
| Tomato                | 0.30-0.61 mg/kg   | (Amrollahi et al., 2018)                                               |
| Carborundum           | 0.09-0.61 mg/L    | (Shahzadi et al., 2013)                                                |
| Carbofuran            | 0.10-0.84 mg/L    | (Shahzadi et al., 2013)                                                |
| Chloramine            | 0.075-1.90 ug/kg  | (Elserogy et al., 2013)                                                |
| Chlordane             | 1.49-6.57 ug/kg   | (Avancini et al., 2013)                                                |
| Chlorothalonil        | 0.0652 mg/kg      | (Jayasinghe et al., 2019)                                              |
| Leafy vegetables      | 0.05 mg/kg        | (Jayasinghe et al., 2019)                                              |
| Maize                 | 0.05 mg/kg        | (Oyeyeio et al., 2017)                                                 |
| Wheat                 | 0.16 ug/kg        | (Oyeyeio et al., 2017)                                                 |
| 8 | Chlorpyrifos | 0.00-3.5 ug/kg | 0.009-0.41 mg/L | 0.04-0.76 mg/L (Shahzadi et al., 2013) | 0.012 mg/kg (Jayasinghe et al., 2019) | 0.012 mg/kg (Jeyasinghe et al., 2019) | 0-12.32 ug/L (Smadi et al., 2019); 4.4 ug/kg (Abbassy, 2017) | 9.3 ug/kg (w/w) (Witzak et al., 2018); Guava-0.25 mg/kg (Qamar et al., 2017); Watermelon - 0.06 mg/kg (Qamar et al., 2017); Peach -0.92 mg/kg (Qamar et al., 2017) | 31 ug/kg (w/w) (Witzak et al., 2018); Tomato -0.83-603.6 mg/kg (Kariathi et al., 2016); 0.018-0.025 mg/kg (Bempah et al., 2012b); 0.012-1.9 mg/kg (Amrollahi et al., 2018); 0.03 mg/kg (Hadian et al., 2019); Salad-0.0-0.090 mg/kg (Farina et al., 2016); Sweet peppers-0.00-0.009 mg/kg (Abdelbagi et al., 2020); Lettuce -0.001-0.021 mg/kg (Bempah et al., 2012b); 0.0-49.5 ug/kg (Bedi et al., 2015) |
5.3 ug/kg (Farina et al., 2016); Cabbage-0.003-0.009 mg/kg (Bhatt et al., 2019); 4.6 ug/kg (Farina et al., 2016); 0.121 mg/kg (Sah et al., 2018); Carrot-0.038-0.044 mg/kg (Bhatt et al., 2019); Onion-0.041-0.062 mg/kg (Bhatt et al., 2019); Cucumber-0.14-0.8 mg/kg (Amrollahi et al., 2018); 0.03 mg/kg (Hadian et al., 2019); Leafy vegetables-0.01-6.86 mg/kg (Elgueta et al., 2017); Cauliflower 4.6 ug/kg (Farina et al., 2016); 0.057 mg/kg (Sah et al., 2018); Spinach 5.3 ug/kg [(Farina et al., 2016); Broccoli-5.3 ug/kg (Farina et al., 2016); Mustard 3.3 ug/kg (Farina et al., 2016); Tomato-0.0-0.08 mg/kg (Jallow et al., 2017); Grapes-0.0-0.98 mg/kg (Ramadan et al., 2017).
1 Cypermethrin 0.0-45.4 ug/kg (Bedi et al., 2015); 0.0-340ug/kg (Gill et al., 2020); 3.9ug/kg (Abbassy, 2017)

Grapes 0.0-0.28 mg/kg (Jallow et al., 2017); Watermelon 0.0-0.09 mg/kg (Jallow et al., 2017); 0.07 mg/ kg (Qamar et al., 2017); Papaya 0.030-0.040mg/ kg (Bempah et al., 2012b); Mango 0.004-0.012 mg/kg (Bempah et al., 2012b);

4.4 ug/kg (Abbassy, 2017) Tomato 0.0-0.24 mg/kg (Jallow et al., 2017); 0.030-0.040 mg/kg (Bempah et al., 2012b); Eggplant 0.0-0.13 mg/kg (Jallow et al., 2017); Cucumber 0.0-0.98 mg/kg (Jallow et al., 2017); 0.006-0.13 mg/kg (Bempah et al., 2012a); 0.017mg/kg

© East African Scholars Publisher, Kenya
| Fruit/Vegetable | Concentration (mg/kg) |
|-----------------|-----------------------|
| Pineapple       | 0.019-0.025           |
| Banana          | 0.007-0.012           |
| Oranges         | 0.14                  |
| Salad           | 0.0-0.02              |
| Cabbage         | 0.007-0.012           |
| Carrot          | 0.010-0.018           |
| Leafy vegetables| 0.0-1.61              |
| Okra            | 0.112-0.347           |
| Brinjal         | 0.407                 |
| Cauliflower     | 0.378                 |
| Chilli pepper   | 0.111                 |
| Tomato          | 0.0-0.78              |
| Maize           | 1.34                  |
| Wheat           | 1.92                  |
| Sorgum          | 3.3                   |
| Papaya          | 0.008-0.014           |
| Tomato          | 0.0-0.029mg/kg        |
| Maize           | 1.92                  |
| Carrot          | 0.010-0.018           |
| Leafy vegetables| 0.0-1.61              |
| Okra            | 0.112-0.347           |
| Brinjal         | 0.407                 |
| Cauliflower     | 0.378                 |
| Chilli pepper   | 0.111                 |
| Tomato          | 0.0-0.78              |
| Maize           | 1.34                  |
| Wheat           | 1.92                  |
| Sorgum          | 3.3                   |

**Notes:**
- Concentrations are given as ranges where applicable.
- DDT/DDE levels are also included for some items.
- Concentrations are given as ratios or specific amounts per kilogram (kg) or per unit of measurement (ug/kg, mg/kg, etc.).
| Food          | Concentration Unit | Concentration Range | Source |
|--------------|--------------------|---------------------|--------|
| Banana       | ug/kg              | 0.018 - 0.018       | Bempah et al., 2012b |
|              | ug/kg              | 0.001 - 0.01       | Luzardo et al., 2012 |
|              | ug/kg              | 0.001 - 0.001      | Elsero et al., 2013 |
|              | ug/kg              | 12.95 - 95.90      | Witczak et al., 2016 |
|              | mg/kg              | 0.06 - 20.21       | Ishaq & Nawaz, 2018 |
|              | g                 | 0.050              | Kampire et al., 2011 |
|              | g                 | 0.045 - 0.089      | Kiranmai et al., 2011 |
|              | g                 | 0.005 - 0.062      | Bergkvist et al., 2012 |
|              | g                 | 0.011 - 0.019      | Bempah et al., 2012b |
|              | g                 | 21.2               | Haque et al., 2017 |
|              | g                 | 128.169            | Hassine et al., 2012 |
|              | g                 | 6.5 - 8.4          | Hassine et al., 2014 |
|              | g                 | 4.5 - 11.5         | Elbashi et al., 2015 |
|              | ug/kg              | 21.9               | Forkuph et al., 2018 |
|              | ug/kg              | 2.74               | Abbasay, 2017 |
|              | ug/kg              | 490                | Luzardo et al., 2012 |
|              | ug/kg              | 7.86               | Luzardo et al., 2014 |
|              | ug/kg              | 6-20.21            | Witczak et al., 2016 |
|               | mg/kg fat          | 0.089              | Kampire et al., 2011 |
|               | ug/kg              | 0.050              | Kampire et al., 2011 |
|               | ug/kg              | 116.4              | Ntow, 2001 |
|               | ug/kg              | 128.169            | Hassine et al., 2012 |
|               | ug/kg              | 6.5 - 8.4          | Hassine et al., 2014 |
|               | ug/kg              | 4.5 - 11.5         | Elbashi et al., 2015 |
|               | ug/kg              | 21.9               | Forkuph et al., 2018 |
|               | ug/kg              | 2.74               | Abbasay, 2017 |
|               | ug/kg              | 490                | Luzardo et al., 2012 |
|               | ug/kg              | 7.86               | Luzardo et al., 2014 |
|               | ug/kg              | 6-20.21            | Witczak et al., 2016 |
|               | mg/kg fat          | 0.089              | Kampire et al., 2011 |
|               | ug/kg              | 0.050              | Kampire et al., 2011 |
|               | ug/kg              | 116.4              | Ntow, 2001 |
|               | ug/kg              | 128.169            | Hassine et al., 2012 |
|               | ug/kg              | 6.5 - 8.4          | Hassine et al., 2014 |
|               | ug/kg              | 4.5 - 11.5         | Elbashi et al., 2015 |
|               | ug/kg              | 21.9               | Forkuph et al., 2018 |
|               | ug/kg              | 2.74               | Abbasay, 2017 |

© East African Scholars Publisher, Kenya
0.51.03 ug/kg lipid (Kao et al., 2019); 0.21-7.76 ug/L (Du et al., 2016); 0.12-2.38 mg/kg fat (Al Antary et al., 2015); kg (Bempah et al., 2012b); 115.5 ug/kg (Oyeyiola et al., 2017); 66.1 ug/kg (Olatunji, 2019); 0.046-0.071 mg/kg (Koranteng et al., 2017); Cucumber-0.005-0.013 mg/kg (Bempah et al., 2012b); 42 ug/kg (Oyeyiola et al., 2017); 42.2 ug/kg (Olatunji, 2019); Chilli pepper-0.004-0.0034 mg/kg (Koranteng et al., 2017); 123.5 ug/kg (Oyeyiola et al., 2017); Cauliflower 15.2ug/kg (Farina et al., 2016); 41.2 ug/kg (Abou-Arab et al., 2014); Spinach 4.6 ug/kg (Farina et al., 2016); 1.2ug/kg (Olatunji, 2019); Broccoli-9.43 ug/kg
|   | Insecticide | Concentration Range | References |
|---|-------------|---------------------|------------|
| 1 | Deltamethrin | 0.06-0.75 mg/L | (Shahzadi et al., 2013) |
|   |            | 0.0579-0.80 mg/L | (Shahza di et al., 2013) |
|   |            | 0.07-0.60 mg/L | (Shahza di et al., 2013) |
| 2 | Diazinon    | 0.0378 mg/kg | (Jayasinghe et al., 2019) |
|   |            | 0.0155 mg/kg | (Jayasinghe et al., 2019) |
| 3 | Thrin       | 0.06-0.75 mg/kg | (Shahzadi et al., 2013) |
|   |            | 0.0579-0.80 mg/kg | (Shahza di et al., 2013) |
|   |            | 0.07-0.60 mg/kg | (Shahza di et al., 2013) |

- Apple: 0.2-0.32 mg/kg (Jallow et al., 2017)
- Grapes: 0.032-0.38 mg/kg (Jallow et al., 2017)
- Strawberry: 0.09 mg/kg (Jallow et al., 2017)
- Watermelon: 0.06-0.29 mg/kg (Jallow et al., 2017)
- Peer: 0.007-0.023 mg/kg (Bempah et al., 2012b)
- Sweet peppers: 0.00-0.066 mg/kg (Abdelbagi et al., 2020)

- Salad: 0.0-0.021 mg/kg (Akomea-Frempong et al., 2017)
- Lettuce: 0.009-0.020 mg/kg (Bempah et al., 2012b)
- Carrot: 0.015-0.063 mg/kg (Bempah et al., 2012b)
- Onion: 0.012-0.045 mg/kg (Bempah et al., 2012b)
- Radish: 46.36 ug/kg (Olatunji, 2019)
- Apple: 0.0-0.08 mg/kg (Jallow et al., 2017)
- Strawberry: 0.0-0.12 mg/kg (Jallow et al., 2017)
- Pineapple: 0.026-0.062 mg/kg (Bempah et al., 2012b)
- Banana: 0.008-0.040 mg/kg (Bempah et al., 2012b)
- Sweet peppers: 0.00-0.066 mg/kg (Abdelbagi et al., 2020)
0.009mg/ kg (Bempah et al., 2012b); Tomato-0.003-0.013mg/kg (Bempah et al., 2012b); 0.05-0.109mg/kg (Amrollahi et al., 2018); Lettuce-0.002-0.006mg/ kg (Bempah et al., 2012b); 3.8ug/kg (Farina et al., 2016); Cabbage-0.010-0.019mg/kg (Bempah et al., 2012b); 20ug/kg (Farina et al., 2016); 0.009mg/kg (Ramadan et al., 2020); Carrot -0.003-0.011mg/kg (Bhatt et al., 2019); Cucumber-0.003-0.011mg/kg (Bempah et al., 2012b); 0.032-0.51mg/kg (Amrollahi et al., 2018); Onion - 0.004-0.010mg/kg (Bempah et al., 2012b); Cauliflower-13.3ug/kg (Farina et al., 2016); Spinach 20ug/kg (Farina et al., 2016); Mustard 1.1ug/kg (Farina et al., 2016); Chili pepper-0.013-0.026
| 1 | Dichlorvos | 0.006-0.018 mg/kg (Ramadan et al., 2020) |
|---|---|---|
| 2 | Cabbage | 0.14-0.173 mg/kg (Avancini et al., 2013) |
| 3 | Tomatoes | 0.0002-0.040 mg/kg (Bempah et al., 2012b) |
| 4 | Maize | 0.00092-0.00275 mg/kg (Bolton & others, 2018) |
| 5 | Dieldrin | 0.0007-0.0271 mg/kg (Koranteng et al., 2017) |
| 6 | Aldrin | 0.0005-0.002 mg/kg (Bempah et al., 2012b) |
| 7 | Wheat | 0.0003-0.012 mg/kg (Oyeyiola et al., 2017) |
| 8 | Sorgum | 0.0003-0.012 mg/kg (Oyeyiola et al., 2017) |
| 9 | Cucumber | 0.00005-0.013 mg/kg (Bempah et al., 2012b) |
| 10 | Cowpea | 0.00092-0.00275 mg/kg (Bolton & others, 2018) |
| 11 | Maize | 0.00092-0.00275 mg/kg (Bolton & others, 2018) |
| 12 | Wheat | 0.0003-0.012 mg/kg (Oyeyiola et al., 2017) |
| 13 | Sorgum | 0.0003-0.012 mg/kg (Oyeyiola et al., 2017) |
| 14 | Millet | 0.0003-0.012 mg/kg (Oyeyiola et al., 2017) |
| 15 | Beans | 0.0003-0.012 mg/kg (Oyeyiola et al., 2017) |
| 16 | Onion | 0.004-0.008 mg/kg (Bempah et al., 2012b) |
| 17 | Cucumber | 0.00005-0.013 mg/kg (Bempah et al., 2012b) |

- **Dichlorvos**
  - **Cabbage**: 0.005-0.018 mg/kg (Ramadan et al., 2020)
  - **Tomato**: 0.0-0.457 mg/kg (Kolan et al., 2016) *d.w.*
  - **Maize**: 0.00092-0.00275 mg/kg (Bolton & others, 2018)

- **Dieldrin / Aldrin**
  - **Cabbage**: 0.26 ug/kg (Qamar et al., 2017)
  - **Tomato**: 0.0-0.457 ug/kg (Kolan et al., 2016) *d.w.*
  - **Maize**: 0.00092-0.00275 mg/kg (Bolton & others, 2018) *d.w.*

- **Cucumber**
  - **Cowpea**: 0.36 mg/kg (Oyeyiola et al., 2017)

- **Other Fruits and Vegetables**
  - **Papaya**: 0.002-0.040 mg/kg (Avancini et al., 2013)
  - **Watermelon**: 2.21 ug/kg (Oyeyiola et al., 2017)
  - **Tomato**: 0.0-0.457 mg/kg (Kolan et al., 2016) *d.w.*
  - **Maize**: 0.00092-0.00275 mg/kg (Bolton & others, 2018) *d.w.*

- **Grains**
  - **Maize**: 0.36 mg/kg (Oyeyiola et al., 2017)
  - **Wheat**: 3.52 ug/kg (Oyeyiola et al., 2017)
  - **Sorgum**: 0.38 mg/kg (Oyeyiola et al., 2017)
  - **Millet**: 0.38 mg/kg (Oyeyiola et al., 2017)
| Fruit/Vegetable | Amount (mg/kg) |
|----------------|---------------|
| Difenocanazole | 81.5 mg/kg    |
| Eggplant       | 5.62 mg/kg    |
| Round Gourd    | 61.53 mg/kg   |
| Sweet peppers  | 0.115-0.248 mg/kg |
| Leafy vegetables | 0.0-0.08 mg/kg (Elgue et al., 2017) |
| Papaya         | 0.002-0.012 mg/kg (Jayasinghe et al., 2019) |
| Mango          | 0.004-0.018 mg/kg (Bempah et al., 2012b) |
| Pineapple      | 0.002-0.008 mg/kg (Bempah et al., 2012b) |
| Watermelon     | 0.004-0.006 mg/kg (Bempah et al., 2012b) |
| Tomato         | 0.007-0.019 mg/kg (Bempah et al., 2012b) |
| Onion          | 0.002-0.008 mg/kg (Bempah et al., 2012b) |
| #  | Nutrient            | Foods                          | Sources                                                                 |
|----|---------------------|--------------------------------|-------------------------------------------------------------------------|
| 1  | Dimethomorph        | Gauva                          | 0.48 mg/kg (Akhtar et al., 2018)                                        |
| 2  |                    | Eggplant                       | 0.25 mg/kg (Kol & Bhargava, 2018)                                       |
| 3  |                    | Round Gourd                    | 0.15 mg/kg (Kolar et al., 2018)                                         |
| 4  |                    | Watermelon                     | 0.06 mg/kg (Hadian et al., 2019); 0.29 ug/kg (Oyeyiola et al., 2017)    |
| 5  |                    | Maize                          | 0.08 ug/kg (Bedi et al., 2015); 0.40-1.2 ug/kg (Kolar & Bhargava, 2018) |
| 6  |                    | Wheat                          | 0.08 ug/kg (Kolar et al., 2018); 0.17 ug/kg (Oyeyiola et al., 2017)     |
| 7  |                    | Lettuce                        | 0.0-130 ug/kg (Gill et al., 2020)                                       |
| 8  |                    | Onions                         | 0.0-3.8 mg/kg (Bedi et al., 2015); 0.0007-0.0033 mg/kg (Bhinchhar, 2018) |
| 9  | Endosulfan          | Capra, 28.47 ug/kg             | 0.08 ug/kg (Bolar et al., 2018); 0.312 mg/kg (Kolar et al., 2018)       |
|    |                     | 47.8 ug/kg (Ishaq & Nawaz, 2018); 0.002 mg/kg (Kampire et al., 2011); 0.006 mg/kg (Kiranmai et al., 2018); 0.0-27.6 ug/kg (Bedi et al., 2015); 0.0-130 ug/kg (Gill et al., 2020) | 0.0155-5.43 ug/kg (Bempah et al., 2012b); 0.28-12.2 ug/kg (Avancini et al., 2013); 0.0165-5.43 ug/kg (Kolar et al., 2018); 0.0-5.45 ug/kg (Sleep et al., 2017); 0.0-27.6 ug/kg (Bolar et al., 2018); 0.0-130 ug/kg (Gill et al., 2020) |
2.80 ug/kg (Bolor et al., 2018); Sweet peppers - 0.00-0.0889 mg/kg (Abdelbagi et al., 2020); Tomato - 0.09-0.29 mg/kg (Amrollahi et al., 2018); Chilli pepper - 0.002-0.012 mg/kg (Koranteng et al., 2017); 0.29 ug/kg (Oyeyiola et al., 2017); Cauliflower - 10 ug/kg (Farina et al., 2016); 0.943-2.870 mg/kg (Sah et al., 2018); Spinach - 7.3 ug/kg (Farina et al., 2016); Broccoli - 6.6 ug/kg (Farina et al., 2016); Okra - 0.864-1.128 mg/kg (Sah et al., 2018); 0.021 mg/kg (Bhatt et al., 2019); Brinjal - 0.276-0.385 mg/kg (Sah et al., 2018); Cauliflower...
2. Fenprop 0.0-1.2 mg/kg (Jallow et al., 2017; Bempah et al., 2012b; Bhatt et al., 2019)

0.018-0.021 mg/kg (Bempah et al., 2012b)

0.006-0.014 mg/kg (Bempah et al., 2012b)

0.013-0.021 mg/kg (Bempah et al., 2012b)

Salad-0.0-0.05 mg/kg (Akomea-Frempong et al., 2017; Hadian et al., 2019; Bempah et al., 2012b)

0.010-0.016 mg/kg (Bempah et al., 2012b)

0.05 mg/kg (Hadian et al., 2019; Bempah et al., 2012b)

0.003-0.017 mg/kg (Bempah et al., 2012b; Hadian et al., 2019; Bempah et al., 2012b)

11.8 ug/kg (Farina et al., 2016; Sah et al., 2018; Oyeyiola et al., 2017)

0.0-0.560 mg/kg (Sah et al., 2018; Bempah et al., 2012b)

Carrot-0.004-0.008 mg/kg (Oyeyiola et al., 2017)
(Bempah et al., 2012b); Cucumber-0.007-0.013 mg/kg (Bempah et al., 2012b); Onion-0.014-0.022 mg/kg (Bempah et al., 2012b); Cauliflower 11.8ug/kg (Farina et al., 2016); Spinach 11.3ug/kg (Farina et al., 2016); Broccoli-4.8ug/kg (Farina et al., 2016); Mustard 9.3ug/kg (Farina et al., 2016); Okra-0.588 mg/kg (Sah et al., 2018); Cauliflower-0.081-0.164 mg/kg (Sah et al., 2018)

|   |   |   |   |
|---|---|---|---|
| 2 | Fipronil | 0.190mg/kg | 0.086 mg/kg |
|   |   | (Jayasinghe et al., 2019) |   |
|   |   | 0.0-110ug/kg |   |
|   |   | (Gill et al., 2020) |   |
| 2 | HCB | 0.019-0.033 mg/kg | 0.007 mg/kg |
|   |   | (Shaker et al., 2015); 0.027 mg/kg | fat |
|   |   | (Kiranmai et al., 2018); 0.016 mg/kg | (Aytenfsu et al., 2016) |
|   |   | fat |   |
|   |   | (Aytenfsu et al., 2016) |   |
| 2 | Hepachlor | 0.002-0.60 ug/kg | 1.22-6.02 |
| 4 | lor | 5.01ug/ | 0.0728- |
|   |   | -0.001-0.027 | Watermelon |
|   |   | 0.20-2.30 | Lettuce- |
|   |   | 1.68ug/ | Maize- |
| Vegetable          | mg/kg (Kiranmaya et al., 2018) | ug/kg (Kora et al., 2017) | kg (Oyeyiola et al., 2017) | kg (Oyeyiola et al., 2017) |
|--------------------|---------------------------------|---------------------------|-----------------------------|-----------------------------|
| Onion              | 0.72                            | 0.01-0.254                | 0.001-0.501                 | 0.001-0.254                 |
| Sweet peppers      | 0.030-0.069                     |                            | 0.10-0.41                   | 0.10-0.41                   |
| Cabbage            | 0.001-0.248                     | 0.001-0.248               | 0.04-0.80                   | 0.04-0.80                   |
| Carrot             | 0.72                            | 0.043-0.116               | 0.04-0.80                   | 0.043-0.116                 |
| Tomato             | 0.68                            | 0.043-0.116               | 0.04-0.80                   | 0.043-0.116                 |
| Cowpea             | 1.16                            | 0.043-0.116               | 0.04-0.80                   | 0.043-0.116                 |
| Cucumber           | 1.16                            | 0.043-0.116               | 0.04-0.80                   | 0.043-0.116                 |
| Chilli pepper      | 0.82                            | 0.043-0.116               | 0.04-0.80                   | 0.043-0.116                 |
| Green pepper       | 0.82                            | 0.043-0.116               | 0.04-0.80                   | 0.043-0.116                 |
| Gauva              | 1.65                            |                            | 0.04-0.80                   | 0.043-0.116                 |
| Tomato             | 0.0-0.51                        |                            | 0.04-0.80                   | 0.043-0.116                 |
| Apple              | 0.0-0.65                        |                            | 0.04-0.80                   | 0.043-0.116                 |
| Grapes             | 0.0-0.98                        |                            | 0.04-0.80                   | 0.043-0.116                 |
| Eggplants          | 0.0-0.09mg/                      |                            | 0.04-0.80                   | 0.043-0.116                 |

| Fruit              | ug/kg (Bolor et al., 2018)      | Kg (Oyeyiola et al., 2017) | Kg (Oyeyiola et al., 2017) | Kg (Oyeyiola et al., 2017) |
|--------------------|---------------------------------|-----------------------------|-----------------------------|-----------------------------|
| Gauva              | 1.65                            | 1.001-0.248                 | 1.001-0.248                 | 1.001-0.248                 |
| Apple              | 0.0-0.65                        | 0.001-0.248                 | 0.001-0.248                 | 0.001-0.248                 |
| Grapes             | 0.0-0.98                        | 0.001-0.248                 | 0.001-0.248                 | 0.001-0.248                 |
| Eggplants          | 0.0-0.09mg/                      | 0.001-0.248                 | 0.001-0.248                 | 0.001-0.248                 |
| Wheat              | 1.24                            | 1.001-0.248                 | 1.001-0.248                 | 1.001-0.248                 |
| Sorgum             | 1.26                            | 1.001-0.248                 | 1.001-0.248                 | 1.001-0.248                 |
| Beans              | 1.1                              | 1.001-0.248                 | 1.001-0.248                 | 1.001-0.248                 |
| Cowpea             | 2.7                              | 1.001-0.248                 | 1.001-0.248                 | 1.001-0.248                 |
| Cucumber           | 1.16                             | 1.001-0.248                 | 1.001-0.248                 | 1.001-0.248                 |
| Chilli pepper      | 0.82                             | 1.001-0.248                 | 1.001-0.248                 | 1.001-0.248                 |
| Green pepper       | 0.82                             | 1.001-0.248                 | 1.001-0.248                 | 1.001-0.248                 |
| Gauva              | 1.65                             | 1.001-0.248                 | 1.001-0.248                 | 1.001-0.248                 |
| Tomato             | 0.0-0.51                         | 1.001-0.248                 | 1.001-0.248                 | 1.001-0.248                 |
| Apple              | 0.0-0.65                         | 1.001-0.248                 | 1.001-0.248                 | 1.001-0.248                 |
| Grapes             | 0.0-0.98                         | 1.001-0.248                 | 1.001-0.248                 | 1.001-0.248                 |
| Eggplants          | 0.0-0.09mg/                      | 1.001-0.248                 | 1.001-0.248                 | 1.001-0.248                 |

| Other             | mg/kg                            | ug/kg                        | Kg (Oyeyiola et al., 2017) | Kg (Oyeyiola et al., 2017) |
|-------------------|----------------------------------|------------------------------|-----------------------------|-----------------------------|
| Imidacloprid      | 0.111-0.99                       | 0.10-0.41                    | 0.04-0.80                   | 0.04-0.80                   |
| Gauva             | 1.65                             | 0.043-0.116                  | 0.04-0.80                   | 0.043-0.116                 |
| Tomato            | 0.0-0.51                         | 0.043-0.116                  | 0.04-0.80                   | 0.043-0.116                 |
| Apple             | 0.0-0.65                         | 0.043-0.116                  | 0.04-0.80                   | 0.043-0.116                 |
| Grapes            | 0.0-0.98                         | 0.043-0.116                  | 0.04-0.80                   | 0.043-0.116                 |
| Eggplants         | 0.0-0.09mg/                      | 0.043-0.116                  | 0.04-0.80                   | 0.043-0.116                 |

© East African Scholars Publisher, Kenya
| Fruit/VEG          | Range          |
|-------------------|----------------|
| Strawberry        | 0.0-0.2mg/kg   |
| (Jallow et al., 2017) |               |
| Strawberry        | 0.045mg/kg     |
| (Ramadan et al., 2020) |           |
| Cucumber          | 0.05-1.2mg/kg  |
| (Jallow et al., 2017) |           |
| Cucumber          | 0.071-0.199mg/kg |
| (Ramadan et al., 2020) |       |
| Leafy vegetables  | 0.02-0.18mg/kg |
| (Elgueta et al., 2017) |          |
| Cabbage           | 0.014-0.051mg/kg |
| (Elgueta et al., 2017) |          |
| Onion             | 0.019-0.053mg/kg |
| (Elgueta et al., 2017) |          |
| Potato            | 0.031-0.076mg/kg |
| (Elgueta et al., 2017) |          |
| Carrot            | 0.000-0.002mg/kg |
| (Bempah et al., 2012a) |          |
| Cabbage           | 0.000-0.001mg/kg |
| (Bempah et al., 2012) |           |
| Lettuce           | 0.000-0.001mg/kg |
| (Bempah et al., 2012) |           |
|   | Malathion     | 0.188-0.989 ug/kg (Shaiker & Elsharkawy, 2015) | 0.002-0.006 mg/kg (Bempah et al., 2012b) |
|---|--------------|---------------------------------------------|----------------------------------------|
| 2 | 8 Malathi on  | 0.188-0.989 ug/kg (Shaiker & Elsharkawy, 2015) | 0.002-0.006 mg/kg (Bempah et al., 2012b) |
|   |               |                                             | Apple- 0.09-0.58 mg/kg (Jallow et al., 2017) |
|   |               |                                             | Tomato-0.005-0.062 mg/kg(Bempah et al., 2012b) |
|   |               |                                             | Strawberry-0.0-0.98 mg/kg (Jallow et al., 2017) |
|   |               |                                             | Lettuce-0.001-0.006 mg/kg(Bempah et al., 2012b) |
|   |               |                                             | Cucumber-0.002-0.008 mg/kg(Bempah et al., 2012b) |
|   |               |                                             | Papaya-0.002-0.006 mg/kg (Bempah et al., 2012b) |
|   |               |                                             | Cabbage-0.004-0.008 mg/kg(Bempah et al., 2012b) |
|   |               |                                             | Pineapple-0.002-0.008 mg/kg(Bempah et al., 2012b) |
|   |               |                                             | Carrot-0.005-0.011 mg/kg (Bempah et al., 2012b) |
|   |               |                                             | Cucumber-0.008-0.0121 mg/kg (Bempah et al., 2012b) |
|   |               |                                             | 0.011-0.273 mg/kg (Bempah et al., 2012b) |
|   |               |                                             | 0.007-0.013 mg/kg (Sah et al., 2018) |
|   |               |                                             | Carrot-0.005-0.011 mg/kg (Bempah et al., 2012b) |
|   |               |                                             | Cucumber-0.008-0.0121 mg/kg (Bempah et al., 2012b) |
|   |               |                                             | 0.007-0.013 mg/kg (Sah et al., 2018) |
|   |               |                                             | Carrot-0.005-0.011 mg/kg (Bempah et al., 2012b) |
|   |               |                                             | Cucumber-0.008-0.0121 mg/kg (Bempah et al., 2012b) |
|     |              |                | mg/kg                        |
|-----|--------------|----------------|------------------------------|
|     | Methamidophos| 0.0-13.2 ug/L  | (Smadi et al., 2019)        |
|     | Leafy vegetables| 0.01-0.02 mg/kg | (Elgue et al., 2017)        |
|     | Calciumflower| 0.9 ug/kg      | (Farina et al., 2016)       |
|     | Spinach      | 6.0 ug/kg      | (Farina et al., 2016)       |
|     | Broccoli     | 11 ug/kg       | (Farina et al., 2016)       |
|     | Mustard      | 6.4 ug/kg      | (Farina et al., 2016)       |
|     | Tomato       | 0.005-0.008 mg/kg | (Ramadan et al., 2020)     |
|     | Cucumber     | 0.009-0.222 mg/kg | (Farina et al., 2016)     |
|     | Chilli pepper| 0.005-0.199 mg/kg | (Ramadan et al., 2020)     |
|     | Cabbage      | 0.006-0.071 mg/kg | (Ramadan et al., 2020)     |
|     | Onion        | 0.009-        | (Ramadan et al., 2020)     |

- Methamidophos (Methamidophos) 0.0-13.2 ug/L (Smadi et al., 2019)
- Leafy vegetables (Dahshan et al., 2016)
- Calciumflower (Farina et al., 2016)
- Spinach (Farina et al., 2016)
- Broccoli (Farina et al., 2016)
- Mustard (Farina et al., 2016)
- Tomato (Ramadan et al., 2020)
- Cucumber (Ramadan et al., 2020)
- Chilli pepper (Ramadan et al., 2020)
- Cabbage (Ramadan et al., 2020)
- Onion (Ramadan et al., 2020)
| Fruit/Vegetable | Min - Max Values |
|-----------------|-----------------|
| Methoxychlor     | 0.137-0.198 mg/kg (Shaker & Elsharkawy, 2015) |
| Papaya           | 0.0245-0.0618 ug/kg (Bempah et al., 2012b) |
| Carrot           | 0.006-0.012 mg/kg (Bempah et al., 2012b) |
| Cabbage          | 9.02-184.1 ug/kg (Bolor et al., 2018) |
| Cucumber         | 0.018-0.021 mg/kg (Bempah et al., 2012b) |
| Chili pepper     | 0.054-0.057 mg/kg (Rama dan et al., 2020) |
| Tomato           | 0.002-0.008 mg/kg (Bempah et al., 2012b) |
| Onion            | 0.025-0.066 mg/kg (Bolor et al., 2018) |
| Lettuce          | 0.022-0.31 ug/kg (Bolor et al., 2018) |
| Peer             | 0.001-0.062 mg/kg (Koranteng et al., 2017) |
| Potato           | 0.005-0.010 mg/kg (Rama dan et al., 2020) |
| Tomato           | 0.002-0.008 mg/kg (Bempah et al., 2012b) |
| Carrot           | 0.006-0.012 mg/kg (Bempah et al., 2012b) |
| Cucumber         | 0.018-0.021 mg/kg (Bempah et al., 2012b) |
| Chili pepper     | 0.051-0.057 |

Note: The values are provided in various units and for different fruits and vegetables as indicated.
|   | Insecticide          | Concentration (mg/kg) |
|---|----------------------|-----------------------|
| 3 | Monocrotophos        | Watermelon: 0.0-0.02 mg/kg |
|   |                      | Tomato: 0.0-0.02 mg/kg |
|   |                      | Cucumber: 0.0-0.04 mg/kg |
| 3 | Omethoate           | Sweet peppers: 0.007-1.31 mg/kg |
|   |                      | Tomato: 0.0-0.09 mg/kg |
|   |                      | Cucumber: 0.0-0.98 mg/kg |
| 3 | Oxamyl              | Tomato: 0.0-0.03 mg/kg |
|   |                      | Cucumber: 0.0-0.09 mg/kg |
| 3 | Oxyfluorfen         | 0.0239 mg/kg (Jayasinghe et al., 2019) |
|   |                     | 0.02225 mg/kg (Jayasinghe et al., 2019) |
| 3 | Paraquat           | Gauva: 6.6 mg/kg (Akhtar et al., 2018) |
|   |                     | Eggplant: 4.58 mg/kg (Akhtar et al., 2018) |
|   |                     | Round Gourd: 0.51 mg/kg (Akhtar et al., 2018) |
| 3 | Parathion-methyl/ Parathion-ethyl | 0.001-0.002 mg/kg (Sha & Elsharky, 2015) |
|   | Parathion-n-ethyl   | Mango: 0.15 mg/kg (Qamar et al., 2017) |
|   |                      | Guava: 0.25 mg/kg (Qamar et al., 2017) |
|   |                      | Cabbage: 9.9 ug/kg (Farina et al., 2016) |
|   |                      | Cauliflower: 9.9 ug/kg (Farina et al., 2016) |
|   |                      | Lettuce: 3.5 ug/kg (Farina et al., 2016) |
|   |                      | Spinach: 7.9 ug/kg (Farina et al., 2016) |
|   |                      | Broccoli: 21.3 ug/kg (Farina et al., 2016) |
|   |                      | Mustard: 10.06 ug/kg (Farina et al., 2016) |
|   | Perinofos | Papaya | Brinjal |
|---|-----------|--------|---------|
| mg/kg | 0.0006-0.004 | 0.0005-0.032 | 0.102 mg/kg |
| mg/kg | 0.0013-0.0025 | 0.003-0.042 | (Bhatt et al., 2019) |

|   | Permethrin | Tomato |
|---|-------------|--------|
| mg/kg | 0.033-0.042 | 0.69-29.06 |
| mg/kg | 0.042-0.045 | 0.14 mg/kg |

|   | Peer | Salad |
|---|-----|-------|
| mg/kg | 0.004-0.008 | 0.0-0.460 |
| mg/kg | 0.025-0.066 | 6.2 ug/kg |

|   | Pineapple | Cabbage |
|---|-----------|---------|
| mg/kg | 0.022-0.078 | 0.022 |
| mg/kg | 0.025-0.080 | 6.2 ug/kg |

|   | Carrot | Lettuce |
|---|--------|---------|
| mg/kg | 0.03-0.052 | 0.025 |
| mg/kg | 0.03-0.052 | 1.3 ug/kg |

*Note: All values are given in mg/kg or ug/kg as specified in the original text.*
| Compound      | Range       | Reference                                                                |
|---------------|-------------|----------------------------------------------------------------------------|
| Cucumber      | 0.003-0.009 mg/kg | (Bempah et al., 2012b)                                                      |
|               | 0.56-0.96 mg/kg  | (Amrollahi et al., 2018)                                                   |
| Leafy vegetables | 0.0-1.45 mg/kg | (Elgueta et al., 2017)                                                     |
| Cauliflower   | 7.9 ug/kg   | (Farina et al., 2016)                                                      |
| Spinach       | 4.9 ug/kg   | (Farina et al., 2016)                                                      |
| Broccoli      | 6.3 ug/kg   | (Farina et al., 2016)                                                      |
| Mustard       | 4.7 ug/kg   | (Farina et al., 2016)                                                      |
| 4 Phenoatel   | 0.101 mg/kg | (Jayasinghe et al., 2019)                                                  |
| 4 Profenofos  | 0.196 mg/kg | (Jayasinghe et al., 2019)                                                  |
|               | 0.003-0.005 mg/kg | (Bempah et al., 2012b)                                                      |
| Papaya        | 0.001-0.005 mg/kg | (Bempah et al., 2012b)                                                      |
| Tomato        | 0.02-0.39 mg/kg | (Jallow et al., 2017)                                                      |
|               | 0.005-0.011 mg/kg | (Bempah et al., 2012b)                                                      |
|               | 0.095-0.231 mg/kg | (Ramadan et al., 2020)                                                     |
|               | 0.002-0.010 mg/kg | (Bempah et al., 2012b)                                                      |
|               | 0.007-0.496 mg/kg | (Ramadan et al., 2020)                                                     |
|               | 0.010-0.016 mg/kg | (Bempah et al., 2012b)                                                      |
|               | 2.66 ug/kg   | (Abbassy, 2017)                                                            |
|               | 0.0364 mg/kg | (Jayasinghe et al., 2019)                                                  |
| Papaya        | 0.001-0.005 mg/kg | (Bempah et al., 2012b)                                                      |
| Tomato        | 0.02-0.39 mg/kg | (Jallow et al., 2017)                                                      |
|               | 0.005-0.011 mg/kg | (Bempah et al., 2012b)                                                      |
|               | 0.095-0.231 mg/kg | (Ramadan et al., 2020)                                                     |
|               | 0.002-0.010 mg/kg | (Bempah et al., 2012b)                                                      |
|               | 0.007-0.496 mg/kg | (Ramadan et al., 2020)                                                     |
|               | 0.010-0.016 mg/kg | (Bempah et al., 2012b)                                                      |

© East African Scholars Publisher, Kenya
| No. | Chemicals       | Units               | Concentrations (mg/kg or ug/L) | Refs                                    |
|-----|----------------|---------------------|--------------------------------|-----------------------------------------|
| 4   | Prothiofos      | mg/kg               | 0.0568                         | (Jayasinghe et al., 2019)               |
| 4   | Tebuconazole    | mg/kg               | 0.062                          | (Jayasinghe et al., 2019)               |
| 4   | Organochlorine  | ug/L                | 133.38                         | (Bulut et al., 2011)                    |
|     | pesticides      | ug/kg fat           | 26.04                          | (Santos et al., 2015)                   |
|     |                 | cheese              | 26.14                          | (Santos et al., 2015)                   |
|     |                 | cheese fat          | 26.14                          | (Santos et al., 2015)                   |
|     |                 | Cheese              | 26.14                          | (Santos et al., 2015)                   |
|     |                 | Cheese fat          | 7.58                           | (Abassy, 2017)                          |
|     |                 | Orange              | 0.006                          | (Smadi et al., 2019)                    |
|     |                 | Orange              | 0.012                          | (Smadi et al., 2019)                    |
|     |                 | Orange              | 0.006                          | (Smadi et al., 2019)                    |
|     |                 | Tomato              | 0.006                          | (Smadi et al., 2019)                    |
|     |                 | Tomato              | 0.013                          | (Smadi et al., 2019)                    |
CONCLUSIONS

The use of pesticides in the agriculture field is indispensable. But since the last 50 years the pesticides are used indiscriminately in agriculture and public health sector.

Surface-water, groundwater, vegetables, fruits, other crops, animal and mother milk are contaminated by pesticides worldwide.

Most of the animal milk (Buffalo, Cow, and Sheep/goat) samples and mother milk samples are contaminated with organochlorine pesticides.

Almost 65-70% of the marketed vegetables and fruits in the developing and developed countries contain one or more than one pesticide beyond its permissible limit

Pesticides are called silent killers as are easily bioaccumulated in the adipose tissues of humans, and animals and persist for a long period.

These pesticides in food pose a serious threat to human health. Breast, prostate cancer; inhibition of acetylcholinesterase enzyme activity; endocrine disruption; diabetes; obesity; cardiovascular diseases; reproductive problems; behavioural changes; neurological and immunodeficiency disorder are some adverse effects of the long-term exposure to pesticides.

To minimize the negative impact of the pesticides on human and environment effective and convenient guidelines must be framed and those should be implemented.

Acknowledgement

No original data has been used in this review all information as accessed from published work.

REFERENCES

1. Bansal, O.P. (2008). Groundwater quality of Aligarh district of Uttar Pradesh, India, A 11-year study. Poll Res, 27, 721-724.
2. Mahmud, M.M., Akan, J.C., & Mohammed, Z., et al., (2015). Assessment of organophosphorus and pyrethroid pesticide residues in Watermelon (Citrullus lanatus) and Soil Samples from Gashua, Bade Local Government Area Yobe State, Nigeria. J Environ Pollut Hum Health, 3 (3), 52-61.
3. Koli, P, & Bhardwaj, N.R. (2018). Status and use of pesticides in forage crops in India. J Pestic Sci, 43(4), 225–232. DOI: 10.1584/jpestics.D18-004
4. Bhinchhar, B.K., Paswan, V.K., Yadav, S.P., et al., (2018). Levels of Aldrin and Endosulfan pesticide residues in green fodders of Varanasi district, Uttar Pradesh, India. Journal of Pharmacognosy and Phytochemistry, 7(4), 791-793
5. Al Antary, T.M., Alawi, M.A., Estiyah, H., et al., (2015). Chlorinated pesticide residues in human breast milk collected from southern Jordan in 2012/2013. Toxin Rev, 34(4), 190–194. DOI: 10.3109/15569543.2015.1132470
6. Abbassy, M.M.S. (2017). Pesticide residues in Buffalo and Human Breast Milk of Vegetables and Fruits Farming Community at Northern of Delta in Egypt. Journal of Environmental & Analytical Toxicology, 7 (2), 1000432. DOI: 10.4172/2161-0525.1000432.
7. Abdelbagi, A. O., Ismail, R. E. A., Ishag, A. E. S. A., & Hammad, A. M. A. (2020). Pesticide Residues in Eggplant Fruit from Khartoum State, Sudan, Journal of Health and Pollution, 10(25), 200304.
8. Abou-Arab, A.A.K., Abou-Donia, M.A., El-Dars, F.M.S.E., et al., (2014). Levels of polycyclic aromatic hydrocarbons (PAHS) in some Egyptian vegetables and fruits and their influences by some treatments. Int J Curr Microbiol App Sci, 3(7), 277-293.
9. Akhtar, S., & Ahad, K. (2017). Pesticides Residue in Milk and Milk Products: Mini Review. Pak J Anal. Environ Chem, 18, 37 – 45. DOI: 10.21743/pjacej/2017.06.03.
10. Akhtar, S., Yaqub, G., Hamid, A., Afzal, Z., & Asghar, S. (2018). Determination of pesticide residues in selected vegetables and fruits from a local market of Lahore, Pakistan. Current World Environment, 13(2).
11. Akomea-Frempong, S., Ofosu, I. W., Owusu-Ansah, E. D. G. J., & Darko, G. (2017). Health risks due to consumption of pesticides in ready-to-eat vegetables (salads) in Kumasi, Ghana. International Journal of Food Contamination, 4(1), 13.
12. Amr, S., Dawson,R., D.A. Saleh, D.A., et al., (2015). Pesticides, gene polymorphisms, and bladder cancer among Egyptian agricultural workers. Arch Environ Occup Health, 70 (1), 19–26. DOI: 10.1080/19338244.2013.853646.
13. Amrollahi, H., Pazoki, R., & Imani, S. (2018). Pesticide Multiresidue Analysis in Tomato and Cucumber Samples Collected from Fruit and Vegetable Markets in Tehran, Iran. Middle East J Rehabil Health Stud, 6(1), e64271. DOI: 10.5812/mejrh.64271.
14. Avancini, R. M., Silva, I. S., Rosa, A. C. S., de Novaes Sarcellini, P., & de Mesquita, S. A. (2013). Organochlorine compounds in bovine milk from the state of Mato Grosso do Sul–Brazil. Chemosphere, 90(9), 2408-2413.
15. Ayoub, M. M., Desoki, M. E., Hassanan, A. S., Thabet, W. M., Mansour, M. H., Loutfy, N. M., & Raslan, A. (2012). Detection of pesticide residues in milk and some dairy products. Journal of Plant Protection and Pathology, 3(8), 865-880.
16. Aytenfsu, S., Mamo, G., & Kebede, B. (2016). Review on Chemical Residues in Milk and Their
Residues of organochlorine pesticides (OCPs) in aquatic environment and risk assessment along Shaying River, China. *Environmental geochemistry and health*, 40(6), 2525-2538.

Bayat, S., Sari, A. E., Bahramifar, N., Younesi, H., & Behroz, R. D. (2011). Survey of organochlorine pesticides and polychlorinated biphenyls in commercial pasteurized milk in Iran. *Environmental monitoring and assessment*, 175(1-4), 469-474.

Bedi, J. S., Gill, J. P. S., Aulakh, R. S., & Kaur, P. (2015). Pesticide residues in bovine milk in Punjab, India: spatial variation and risk assessment to human health. *Archives of environmental contamination and toxicology*, 69(2), 230-240.

Bempah, C. K., Buah-Kwofie, A., Enimil, E., Blewu, B., & Agyei-Martey, G. (2012). Residues of organochlorine pesticides in vegetables marketed in Greater Accra Region of Ghana. *Food control*, 25(2), 537-542. DOI: 10.1016/j.foodcont.2011.11.035.

Bempah, C. K., Asomaning, J., & Boateng, J. (2012b). Market basket survey for some pesticide residues in fruits and vegetables from Ghana. *Journal of Microbiology, Biotechnology and Food Sciences*, 5, 53-67. DOI: 10.1016/j.jmbfs.2012.03.08.

Bhatt, J., Gajera, H.P., Dobariya, D.B., et al., (2019). Residual pesticides analysis of various vegetables by GC-MS. *Research J of Life Sciences Bioinformatics*, *Pharmaceutical & Chemical Science*, 5, 53-67. DOI: 10.26479/2019.0501.06

Blaznik, U., Yngve, A., Eržen, I., & Ribič, C. H. (2016). Consumption of fruits and vegetables and probabilistic assessment of the cumulative acute exposure to organophosphorus and carbamate pesticides of schoolchildren in Slovenia. *Public Health Nutrition*, 19(3), 557-563.

Bolor, V. K., Boadi, N. O., Borquaye, L. S., & Afful, S. (2018). Human risk assessment of organochlorine pesticide residues in vegetables from Kumasi, Ghana. *Journal of Chemistry*, 2018.

Bourguet, D. & Guillemaud, T. (2017). The Hidden and External Costs of Pesticide Use. In: Lichtfouse E. (eds) *Sustainable Agriculture Reviews. Sustainable Agriculture Reviews*, vol 19. Springer, Cham. DOI: 10.1007/978-3-319-26777-7_2.

Bulut, S., Akkaya, L., Gök, V., & Konuk, M. (2011). Organochlorine pesticide (OCP) residues in cow’s, buffalo’s, and sheep’s milk from Afyonkarahisar region, Turkey. *Environmental monitoring and assessment*, 181(1-4), 555-562.

Chen, M.W., Santos, H.M., Que, D.E., et al., (2018). Association between Organochlorine Pesticide Levels in Breast Milk and Their Effects on Female Reproduction in a Taiwanese Population. *Int J Environ Res Public Health*, 15(5), 931. DOI: 10.3390/ijerph15050931

Chourasiya, S., Khillare, P.S.S., & Jyethi, D.S. (2014). Health risk assessment of organochlorine pesticide exposure through dietary intake of vegetables grown in the periurban sites of Delhi, India. *Environmental Science and Pollution Research*, 22(8), 5793-5806.

Chowdhury, M. A. Z., Jahan, I., Karim, N., Alam, M. K., Rahaman, M. A., Moniruzzaman, M., ... & Fakhruddin, A. N. M. (2014). Determination of carbamate and organophosphorus pesticides in vegetable samples and the efficiency of gamma-radiation in their removal. *BioMed Research International*, 2014.

Croom, E.L., Shaffer, T.J., Evans, M.V., et al., (2015). Improving in vitro to in vivo extrapolation by incorporating toxicokinetic measurements: a case study of lindane-induced neurotoxicity. *Toxical Appl Pharmacol*, 283, 9–19. DOI: 10.1016/j.taap.2014.11.006.

Dahshan, H., Megahed, A. M., Abd-Elall, A. M. M., Abd-El-Kader, M. A. G., Nabawy, E., & Elbana, M. H. (2016). Monitoring of pesticides water pollution-the Egyptian River Nile. *Journal of Environmental Health Science and Engineering*, 14(1), 15-30. DOI: 10.1186/s40201-016-0259-6.

Del Prado-Lu, J. (2015). Insecticide Residues in Soil, Water, and Eggplant Fruits and Farmers' Health Effects Due to Exposure to Pesticides. *Environmental Health and Preventive Medicine*, 20, 53-62.

Deti, H., Hymete, A., Bekhit, A. A., Mohamed, A. M. I., & Bekhit, A. E. D. A. (2014). Persistent organochlorine pesticides residues in cow and goat milks collected from different regions of Ethiopia. *Chemosphere*, 106, 70–74. DOI: 10.1016/j.chemosphere.2014.02.012.

Dos Santos, J. S., Schwanz, T. G., Coelho, A. N., Heck-Marques, M. C., Mexia, M. M., Emanuelli, T., & Costabeber, I. (2015). Estimated daily intake of organochlorine pesticides from dairy products in Brazil. *Food Control*, 53, 23-28.

Du, J., Gridneva, Z., Gay, M., et al., (2016). Longitudinal study of pesticide residue levels in human milk from Western Australia during 12 months of lactation: Exposure assessment for infants. *Sci Rep*, 6, 38355. DOI: 10.1038/srep38355.

Elbashir, A.B., Abdelbagi, A.O., A.M.A. Hammad, A.M.A., et al., (2015). Levels of organochlorine pesticides in the blood of people living in areas of intensive pesticide use in Sudan. *Environ Monit Assess*, 187, 68-77. DOI: 10.1007/s10661-015-4269-0.
38. Elgueta, S., Moyano, S., Sepúlveda, P., et al., (2017). Pesticide residues in leafy vegetables and human health risk assessment in North Central agricultural areas of Chile. Food Additives & Contaminants: Part B, 10, 105-112. DOI: 10.1080/19393210.2017.1280540.

39. Elseroug, S., Beshir, S., Saad-Hussein, A., et al., (2013). Organochlorine pesticide residues in biological compartments of healthy mothers. Toxicology and Industrial Health, 29(5), 441-448. DOI: 10.1177/0748233712436645.

40. Ennaceur, S., & Driss, M.R. (2013). Time course of organochlorine pesticides and polychlorinated biphenyls in breast-feeding mothers throughout the first 10 months of lactation in Tunisia. Environ Monit Assess, 185, 1977–1984. DOI: 10.1007/s10661-012-2681-2.

41. Farina, Y., Abdullah, M.P., Bibi, N., et al., (2016). Pesticides residues in agricultural soils and its health assessment for humans in Cameroon highlands Malaysia. Malaysian Journal of Analytical Sciences, 20 (6), 1346 – 1358. DOI: 10.17576/mjas-2016-2006-13.

42. Fatunsin, O. T., Oyeyiola, A. O., Moshood, M. O., Akanbi, L. M., & Fadahunsi, D. E. (2020). Dietary Risk Assessment of Organophosphate and Carbamate Pesticide Residues in Commonly Eaten Food Crops. Scientific African, e00442. DOI: 10.1016/j.sciaf.2020.e00442.

43. Forkuo, F., Boadi, N.O., Borquaye, L.S., et al., (2018). Risk of Human Dietary Exposure to Organochlorine Pesticide Residues in Fruits from Ghana. Sci Rep, 8,16686. DOI: 10.1038/s41598-018-35205-w.

44. Gebremichael, S., Birhanu, T., & 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. Chemosphere, 90, 1652–1657. DOI: 10.1016/j.chemosphere.2012.09.008.

45. Gill, J. P. S., Bedi, J. S., Singh, R., Fairoze, M. N., Hazarika, R. A., Gaurav, A., ... & Kumar, A. (2020). pesticide Residues in peri-Urban Bovine Milk from India and Risk Assessment: A Multicenter Study. Scientific Reports, 10(1), 1-11.

46. Hadian, Z., Eslamizad, S., & Yazdanpanah, H. (2019). Pesticide Residues Analysis in Iranian Fruits and Vegetables by Gas Chromatography-Mass Spectrometry. Iran J Pharm Res, 18(1), 275–285.

47. Haque, R., Inaoka, T., Fujimura, M., et al., (2017). Intake of DDT and its metabolites through food items among reproductive-age women in Bangladesh. Chemosphere, 189, 744-751. DOI: 10.1016/j.chemosphere.2017.09.041.

48. Hassine, S.B., Ameer, W.B., Gandoura, N., et al., (2012). Determination of chlorinated pesticides, polychlorinated biphenyls, and polycrbrinated diphenyl ethers in human milk from Bizerte (Tunisia) in 2010. Chemosphere, 89, 369-377. DOI: 10.1016/j.chemosphere.2012.05.035.

49. Hassine, S.B., Hammami, B., Ameer, W.B., et al., (2014). Concentrations of organochlorine pesticides and polychlorinated biphenyls in human serum and their relation with age, gender, and BMI for the general population of Bizerte, Tunisia. Environ Sci Pollut Res, 21, 6303–6313. DOI: 10.1007/s11356-013-1480-9.

50. Ishaq, S., Sajid, M.W., Saleem, S., et al., (2018). A Perspective on Organochlorine Pesticide Residues in Milk Produced in Pakistan. EC Nutrition, 13(6), 402-410.

51. Ishaq, Z., & Nawaz, M.A. (2018). Analysis of contaminated milk with organochlorine pesticide residues using gas chromatography. International Journal of Food Properties, 21(1), 879-891. DOI: 10.1080/10942912.2018.1460607.

52. Jaacks, L.M., & Staimane, L.R. (2015). Association of persistent organic pollutants and non-persistent pesticides with diabetes and diabetes-related health outcomes in Asia: a systematic review. Environ Int, 76,57–70. DOI:10.1016/j.envint.2014.12.001.

53. Jallow, M. F., Awadh, D. G., Albaho, M. S., Devi, V. Y., & Ahmad, N. (2017). Monitoring of pesticide residues in commonly used fruits and vegetables in Kuwait. International journal of environmental research and public health, 14(8), 833.

54. Jayaraj, R., Megha, P., & Sreedev, P. (2016). Organochlorine pesticides, their toxic effects on living organisms and their fate in the environment. Inter Discip Toxicol, 9(3-4), 90–100. DOI: 0.1515/intox-2016-0012.

55. Jayasinghe, J., Pathirana, S., Dilhani, D., Navaratna, S., Sinhapura, M., Jayasinghe, C., ... & Marapana, U. (2019). Pesticide residues in Cow milk and dairy products from the major milk-producing area of Sri Lanka. Agro for International Journal, 4 (3), 83-89. DOI: 10.7251/AGRENG1903083J

56. Jin, Y., Wang, L., Chen, G., Jin, Y., Wang, L., Chen, G., et al., (2014). Exposure of mice to atrazine and its metabolite diaminochlorotriazine elicits oxidative stress and endocrine disruption. Environ Toxicol Pharmacology, 37, 782–90.DOI:10.1016/j.etap.2014.02.014.

57. Kampire, E., Kiremire, B. T., Nyanzi, S. A., & Kishimba, M. (2011). Organochlorine pesticide in fresh and pasteurized cow's milk from Kampa markets. Chemosphere, 84(7), 923-927.

58. Kao, C-C., Que, D.E., Bongo, S.J., et al., (2019). Residue Levels of Organochlorine Pesticides in Breast Milk and Its Associations with Cord Blood Thyroid Hormones and the Offspring's Neurodevelopment. Int J. Environ Res Public Health, 16, 1438. DOI: 10.3390/ijerph16081438.

59. Kariathi, V., Kassim, N., & Kimanya, M. (2016). Pesticide exposure from fresh tomatoes and its relationship with pesticide application practices in...
82. Ntow, W.J. (2001). Organochlorine Pesticides in Water, Sediment, Crops, and Human Fluids in a Farming Community in Ghana. *Arch Environ Contam Toxicol*, 40(4), 557-63. DOI: 10.1007/s002440010210.

83. Olatunji, O.S. (2019). Evaluation of selected polychlorinated biphenyls (PCBs) congeners and dichlorodiphenyltrichloroethane (DDT) in fresh root and leafy vegetables using GC-MS. *Sci Rep*, 9, 538-547. DOI: 10.1038/s41598-018-36996-8.

84. Oyeyiola, A.O., Fatunsin, O.T. & Akanbi, L.M. (2017). Human Health Risk of Organochlorine Pesticides in Foods Grown in Nigeria. *J Health Pollut.*, 7(15), 63–70. DOI: 10.5696/2156-9614-7.15.63.

85. Pan, H., Lei, H., He, X., Xi, B., & Xu, Q. (2019). Spatial distribution of organochlorine and organophosphorus pesticides in soil-groundwater systems and their associated risks in the middle reaches of the Yangtze River Basin. *Environmental geochemistry and health*, 4(4), 1833-1845.

86. Pandey, S.P. & Mohanty, B. (2014). The neonicotinoid pesticide imidacloprid and the dithiocarbamate fungicide mancozeb disrupt the pituitary-thyroid axis of wildlife birds. *Chemosphere*, 122, 227-234. DOI: 10.1016/j.chemosphere.2014.11.061.

87. Park, A. (2018). Strawberries Top the 'Dirty Dozen' List of Fruits and Vegetables With the Most Pesticides, *TIMES*, APRIL 10, 2018, editors@time.com.

88. Qamar, A., Asi, R., Iqbal, M., Nazir, A., & Arif, K. (2017). Survey of Residual Pesticides in Various Fresh Fruit Crops: A Case Study. *Polish Journal of Environmental Studies*, 26(6), 2703-2709. DOI: 10.15244/pjoes/73801.

89. Rai, P., & Pandey, N.D. (2017). Impact of Pesticide usage on water Resources: Indian Scenario. *Intern J for Res in Applied Sci & Engineering Techn*, 5, 133-138.

90. Ramadan, M.F.A., Abdel-Hamid, M.M.A., Altorgoman, M.M.F., et al., (2020). Evaluation of Pesticide Residues in Vegetables from the Asir Region, Saudi Arabia. *Molecules*, 25, 205-224. DOI: 10.3390/molecules25010205.

91. Raslan, A.A., Elbadry, S. & Darwis, W.S. (2018). Estimation and Human Health Risk Assessment of Organochlorine Pesticides in Raw Milk Marketed in Zagazig City, Egypt. *Hindawi Journal of Toxicology*, 2018, Article ID 3821797, 8 pages. DOI: 10.1155/2018/3821797.

92. Rusu, C., Preda, C., Sireteanu, A., & Vulpoci, C. (2015). Risk factors in autism spectrum disorders: the role of genetic, epigenetic, immune and environmental interactions. *Environmental Engineering & Management Journal (EEMJ)*, 14(4), 901-917. [http://omicron.ch.tuiasi.ro/EEMJ/](http://omicron.ch.tuiasi.ro/EEMJ/).

93. Sah, S.B., Gupta, R.N., Kumar, M., et al., (2018). Pesticide Residues from Farm Gate Vegetable Samples of Vegetables in Bihar. *Int J Curr Microbiol App Sci*, Special Issue-7, 4090-4096.

94. Sajid, M. W., Shamoon, M., Randhawa, M. A., Asim, M., & Chaudhry, A. S. (2016). The impact of seasonal variation on organochlorine pesticide residues in buffalo and cow milk of selected dairy farms from Faisalabad region. *Environmental monitoring and assessment*, 188(10), 589.

95. Sarsemhayeva, N. B., Abdiagalyeva, T. B., Utepova, Z. A., Biletbay, A. N., & Zhumagulova, S. Z. (2019). Heavy metal levels in milk and fermented milk products produced in the Almaty region, Kazakhstan. *Veterinary world*, 13(4), 609.

96. Shahzadi, N., Imran, M., Sarwar, M., Hashmi, A. S., & Wasim, M. (2013). Identification of pesticides residues in different samples of milk. *Journal of Agroalimentary Processes and Technologies*, 19(2), 167-172.

97. Shaker, E.M., & Elsharkawy, E. E. (2015). Organochlorine and organophosphorus pesticide residues in raw buffalo milk from agro-industrial areas in Assiut, Egypt. *Environmental Toxicology and Pharmacology*, 39,433-440. DOI: 10.1016/j.etap.2014.12.005.

98. Sharma, N.D., Chandel, R.S., Sharma, I.D., et al., (2020). Pesticides Contamination of lactating mothers' milk in the North-Western Himalayan region of India. *Journal of Environmental Biology*, 41, 23-28. DOI: 10.22438/jeb/41/1/MRN-1094.

99. Sharma, N., Garg, D., Deb, R., et al., (2017). Toxicological Profile of Organochlorines Aldrin and Dieldrin: An Indian Perspective. *Rev Environ Health*, 32(4), 361-372. DOI: 10.1515/reveh-2017-0013.

100. Shrivastava, P., Singh, P., & Bajpai, A. (2015). Study of adverse effects of pesticides contamination in groundwater. *Journal of Environmental Science Toxic and Food Techno*, 1, 30-33.

101. Smadi, N., Jammoul, A. & El Darra, N. (2019). Assessment of Antibiotic and Pesticides Residues in Breast Milk of Syrian Refugee Lactating Mothers. *Toxics*, 7, 39-52; DOI:10.3390/toxics7030039.

102. Soloneski, S., Kujawski, M., Scuto, A., et al., (2015). Carbamates: a study on genotoxic, cytotoxic, and apoptotic effects induced in Chinese hamster ovary (CHO-K1) cells. *Toxicol in Vitro*, 29, 834–44. DOI: 10.1016/j.tiv.2015.03.011.

103. Steingrímsdóttir, M.M., Petersen, A., & Fantke, P. (2018). A screening framework for pesticide substitution in agriculture. *J of Cleaner Production*, 92, 306-315.

104. Syed, F., John, P.J. & Soni, I. (2015). Neurodevelopmental consequences of gestational and lactation exposure to pyrethroids in rats. *Environ Toxicol*, 31 (12), 1761-1770.DOI: 10.1002/tox.22178.

105. Szpyrka, E., Kurdziel, A., Rupar, J., & Slowik-Borowiec, M. (2015). Pesticide residues in fruit and...
vegetable crops from the central and eastern region of Poland. *Roczniki Państwowego Zakładu Higieny*, 66(2), 107-113.

Trabert, B., Chen, Z., Kannan, K., *et al.*, (2015). Persistent organic pollutants (POPs) and fibroids: results from the ENDO Study. *J Exp Sci Environ Epidemiology*, 25(3), 278–285. DOI: 10.1038/jes.2014.31

United Nations (UN). (2015). Department of Economic and Social Affairs (DESA), 29 July 2015, New York.