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Research Article

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

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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 bio accumulated. 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,

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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 cyclodiene 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 1937from 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. Dithiocarbamate 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 that75-85% 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 in50% 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, 2'Dichlorodiphenyl 1, 1, 1, trichloro ethane) is the most widely known organochlorine pesticide. DDT and its metabolites cause hyperplasia; myeloma; hypertrophy; 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 and most affected parts (Bourguet & Guillemaud, 2017; Amr *et al.*, 2015; Mostafalou & Abdollahi, 2013; Mutiyar & 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). Hexacholorocyclohexane (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 (Mnif *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

SN	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)						Chilli pepper 0.299 mg/kg (Bhatt *et al.*, 2019); Tomato-0.072 mg/kg (Bhatt *et al.*, 2019)		
	Anilifos	88 ug/kg (Dahshan *et al.*, 2016)								
2	BHC/ HCH	0.022-0.049 mg/kg (Akhtar& Ahad, 2017); 4.85ug/g	0.009-0.262 mg/kg fat (Rusu *et al.*, 2015);8.		0.45-2.34 ug/kg fat (Avancini *et al.*, 2013); 31.89 ug/kg fat(Bayat *et al.*, 2011);	90ug/kg dw (Elserougy *et al.*, 2013);0.2-389	Watermelon -0.091-0.172 mg/kg (Koranteng *et al.*, 2017); 0-19.03ug/kg	0.0-11.3ug/kg (Kolani *et al.*, 2016);Cabbage-0.0-93.8 ug/kg	Maize-2.19 ug/kg (Oyeyiola *et al.*, 2017); Wheat	

		(Witczak *et al.*, 2016); 1.32 ug/L (Bulut *et al.*, 2011);0.19-10.18 ug/kg (Ishaq & Nawaz, 2018);0.02-61 mg/kg fat (Kiranmayi *et al.*, 2018); 0.0-67 ug/kg (Gill *et al.*, 2020); 0.094 mg/kg fat (Aytenfsu *et al.*, 2016);113.3ug/kg dw (Raslan *et al.*, 2018); 3.57ug/kg (Abbassy, 2017)	7 ug/kg dw (Raslan *et al.*, 2018)		0.0069-0.170 mg/kg fat (Witczak *et al.*, 2018); 0.015 mg/kg fat (Aytenfsu *et al.*, 2016)	123 ug/kg dw (Bergkvist *et al.*, 2012; Haque *et al.*, 2017);46 ug/ kg dw (Ntow, 2001); 92 ug/kg dw (Elbashir *et al.*, 2015); 5.78 ug/kg (Abbassy, 2017);0.110-0.297 ug/kg lipid (Chen *et al.*, 2018); 0.0-4.53 ug/kg lipid (Kao *et al.*, 2019); 0.59-4.55ug/L (Du *et al.*, 2016); 0.06-1.83 mg/kg fat (Al-Antary *et al.*, 2015)	(Forkuoh *et al.*, 2018)	(Kolani *et al.*, 2016); 3.1-44.7 ug/kg (Bolor *et al.*, 2018); 11.8ug/kg (Bedi *et al.*, 2015); lettuce-0.15-2.63 (Kolani *et al.*, 2016);7.16-22.05 ug/kg (Bolor *et al.*, 2018);6.6 ug/kg (Farina *et al.*, 2016); 0.15-2.63 ug/kg (Bhatt *et al.*, 2019) Onion-0.78-48.35 ug/kg (Bolor *et al.*, 2018);0.046-0.435 mg/kg (Koranteng *et al.*, 2017); Chilli pepper-0.010-0.109 mg/kg (Koranteng *et al.*, 2017); Cauliflower 23.8ug/kg (Farina *et al.*, 2016); Spinach 13.86 ug/kg (Farina *et al.*, 2016); Broccoli-21.2 ug/kg (Farina *et al.*, 2016); Mustard 11.3 ug/kg (Farina *et al.*, 2016); Green pepper 0.18-2.45 ug/kg (Abouy-Arab *et al.*, 2014)	4.42ug/kg (Oyeyiola *et al.*, 2017); Sorgum - 3.83ug/kg (Oyeyiola *et al.*, 2017); Millet-2.0ug/kg (Oyeyiola *et al.*, 2017); Beans 24.04 ug/kg (Oyeyiola *et al.*, 2017); Cowpea -1.8 ug/kg (Oyeyiola *et al.*, 2017;
3	Bifenthrin	0.02-0.52 mg/L (Shahzadi *et al.*,	0.13-0.73 mg/L (Shahza	0.09-0.74 mg/L (Shahza			Gauva-5.13mg/kg (Akhtar *et al.*, 2018);	Eggplant-3.53 mg/ kg (Akhtar *et al.*, 2018);	

		2013)	di *et al.*, 2013]	di *et al.*, 2013)			Watermelon - 0.06 mg/kg (Qamar *et al.*, 2017)	Round Gourd-3.87 mg/kg (Akhtar *et al.*, 2018); Salad-0.0-0.320 mg/kg (Akomea-Frempong *et al.*, 2017)		
4	Carbaryl							Tomato-0.30-0.61 mg/kg (Amrollahi *et al.*,2018)		
5	Carbofuran	0.09-0.61 mg/L (Shahzadi *et al.*, 2013)	0.10-0.84 mg/L (Shahzadi *et al.*, 2013)	0.02-0.74 mg/L Shahzadi *et al.*, 2013)			Watermelon - 0.07 mg/kg (Amrollahi *et al.*, 2018)	Okra 0.021 mg/kg (Bhatt *et al.*, 2019); Brinjal 1.789 mg/kg (Bhatt *et al.*, 2019)		
6	Chlordane				1.49-6.57 ug/kg fat (Avancini *et al.*, 2013)	0.075-1.90ug/kg lipid (Elserougy *et al.*, 2013); 0.0-2.63ug/kg lipid (Haque *et al.*, 2017)	Watermelon - 0.03-0.019 mg/kg(Qamar *et al.*, 2017)	Chilli pepper-0.001-0.006 mg/kg (Koranteng *et al.*, 2017); Onion-0.005-0.019 mg/kg (Koranteng *et al.*, 2017); Tomato-0.001-0.367ug/kg (Kolani *et al.*, 2016); Cabbage-0.001-1.586ug/kg (Kolani *et al.*, 2016); Lettuce-0.001-0.535ug/kg (Kolani *et al.*, 2016)		
7	Chlorothalonil	0.0652 mg/kg (Jayasinghe *et al.*, 2019)			0.05 mg/kg (Jayasinghe *et al.*, 2019)			Leafy vegetables-0.11-1.42 mg/kg (Elgueta *et al.*,2017)]	Maize-0.18ug/kg (Oyeyiola *et al.*, 2017); Wheat 0.16 ug/kg (Oyeyiola *et al.*, 2017);S	0.05 mg/kg (Jayasinghe *et al.*, 2019)

									orgum-0.15ug/kg(Oyeyiola *et al.*, 2017; Millet-0.18ug/kg (Oyeyiola *et al.*, 2017); Beans-0.16ug/kg (Oyeyiola *et al.*, 2017); Cowpea -0.136 ug/ kg (Oyeyiola *et al.*, 2017)	
8	Chlorpyrifos	0.00-3.51ug/kg (Shaker & Elsharkawy,2015); 0.0-45.4 ug/kg (Bedi *et al.*, 2015); 0.0264 mg/kg (Jayasinghe *et al.*, 2019); 1.3-85 ug/kg (Gill *et al.*, 2020); 0.04-0.80 mg/L (Shahzadi *et al.*, 2013); 3.61 ug/kg (Amroollahi *et al.*, 2018)	0.009-0.41 mg/L (Shahzadi *et al.*, 2013)	0.04-0.76 mg/L(Shahzadi *et al.*, 2013)	0.012 mg/kg (Jayasinghe *et al.*, 2019)	0-12.32 ug/L (Smadi *et al.*, 2019); 4.4 ug/kg (Abbassy, 2017)	9.3 ug/kg (w/w) (Witczak *et al.*, 2018); Guava-0.25 mg/kg (Qamar *et al.*, 2017); Watermelon - 0.06mg/kg (Qamar *et al.*, 2017);Peach -0.92 mg/kg (Qamar *et al.*, 2017)	31ug/kg (w/w) Witczak *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 5.3ug/kg [(Farina *et al.*, 2016);Broccoli- 5.3ug/kg (Farina *et al.*, 2016); Mustard 3.3 ug/kg(Farina *et al.*, 2016)
9	Chlorpyrifos-methyl	2.34 ug/kg (Abbassy, 2017)		2.66 ug/kg kg (Abbassy, 2017)	Apple-0.0-0.14 mg/kg (Jallow *et al.*, 2017); Grapes-0.0-0.98 mg/kg	Tomato- 0.0-0.08 mg/kg (Jallow *et al.*, 2017); 0.061mg/kg (Ramadan *et*

						(Jallow *et al.*, 2017); Strawberry-0.0-0.20 mg/kg (Jallow *et al.*, 2017); Papaya-0.004-0.010 mg/kg (Bempah *et al.*, 2012b); Mango-0.003-0.007 mg/kg (Bempah *et al.*, 2012b);Peer -0.012-0.025 mg/kg (Bempah *et al.*, 2012b) ;Pineapple-0.041-0.062 mg /kg (Bempah *et al.*,2012b); Watermelon -0.002-0.005mg/ kg (Bempah *et al.*, 2012b); Banana-0.004-0.012 mg/kg (Bempah *et al.*, 2012b)	*al.*, 2020); Carrot-0.0-0.03 mg/kg (Jallow *et al.*, 2017); Cucumber-0.0-0.98 mg/kg (Jallow *et al.*, 2017);Chilli pepper-0.007-0.051 mg/kg (Ramadan *et al.*, 2020); Cabbage-0.005 -0.008 mg/kg (Ramadan *et al.*, 2020);Onion -0.004-0.008mg/kg (Ramadan *et al.*, 2020); Eggplant-0.017-0.026 mg/kg (Ramadan *et al.*, 2020); Potato-0.004-0.008 mg/kg (Ramadan *et al.*, 2020)		
10	Cypermethrin	0.0-45.4 ug/kg (Bedi *et al.*, 2015); 0.0-340ug/kg (Gill *et al.*, 2020); 3.94 ug/kg (Abbassy, 2017)			4.4 ug/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);	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		0.0-64.4 ug/kg [39]

							0.50mg/kg (Qamar *et al.*, 2017); Pineapple-0.019-0.025 mg/kg (Bempah *et al.*, 2012b); Banana-0.007-0.012 mg/kg (Bempah *et al.*, 2012b);Orange-0.14 mg/kg (Qamar *et al.*, 2017)	(Ramadan *et al.*, 2020) Salad-0.0-0.002 mg/kg(Akomea-Frempong *et al.*, 2017); Cabbage-0.007-0.012 mg/kg (Bempah *et al.*, 2012a); 0.0-0.072 mg/kg (Sah *et al.*, 2018); 0.056 mg/kg (Bhatt *et al.*, 2019);Carrot -0.010-0.018 mg/kg (Bempah *et al.*, 2012a); Leafy vegetables -0.0-1.61 mg/kg(Elgueta *et al.*, 2017); Okra-0.112-0.347 mg/kg(Sah *et al.*, 2018); 0.196-0.736 mg/kg (Bhatt *et al.*, 2019); Brinjal-0.407 mg/kg (Sah *et al.*, 2018)]; Cauliflower-0.378 mg/kg (Sah *et al.*, 2018); Chilli pepper-0.111 mg/kg (Ramadan *et al.*, 2020)	
11	DDT/ DDE	0.089 mg/kg (Akhtar & Ahad, 2017); 138 ug/kg (Dahshan *et al.*, 2016); 4.714 ug/kg (Ayoub *et al.*, 2012);	269-477 ug/kg (Gebremichael *et al.*, 2013); 54.8 ug/kg dw. (Raslan *et al.*, 2018); 1230	874 ug/kg dw (Deti *et al.*, 2014)	0.58-16.2 ug/kg fat (Avancini *et al.*, 2013); 21.65 ug/kg fat (Bayat *et al.*, 2011); 0.040 mg/kg fat (Kampire *et al.*, 2011)	6420-17170 ug/kg (Gebremichael *et al.*, 2013); 0.0-1100 (Ennaceur & Driss, 2013);	Papaya-0.008-0.014 mg/kg (Bempah *et al.*, 2012b);Mango-0.018-0.021 mg/kg(Bempah *et al.*,2012b): Watermelon -0.010-	Tomato: 0.0-0.78 ug/kg (Kolani *et al.*, 2016); 571 ug/kg (Bempah *et al.*, 2012a);0.015 -0.029mg/kg (Bempah *et al.*, 2012b); 106ug/kg (Farina *et*	Maize-1.34 ug/kg (Oyeyiola *et al.*, 2017); Wheat 1.92 ug/kg [64]; Sorgum 223.3ug /kg

	4.85 ug/kg (Luzardo *et al.*, 2012); 7.86 ug/g (Witczak *et al.*, 2016);0.26-20.21 ug/kg (Ishaq & Nawaz, 2018) ; 0.050 mg/kg fat (Kampire *et al.*, 2011); 0.045-0.089mg/kg (Kiranmayi *et al.*, 2018); 0.0- 22.8 ug/kg (Bedi *et al.*, 2015); 0.53-170 ug/kg (Gill *et al.*, 2020); 0.159 mg/kg fat (Aytenfsu *et al.*, 2016); 112.7.8 ug/kg d.w.(Raslan *et al.*, 2018); 2.74 ug/kg (Abbassy, 2017)	ug/kg dw (Deti *et al.*, 2014)		490 ug/kg dw (Elserougy *et al.*, 2013); 12-9590 ug/kg dw (Bergkvist *et al.*, 2012; Haque *et al.*, 2017); 78 ug/kg dw (Ntow, 2001); 1164ug/kgdw (Hassine *et al.*, 2012); 128-169 ug/kg dw (Hassine *et al.*, 2014); 6.5-84 ug/kg dw (Elbashir *et al.*, 2015); 124 ug/kg dw (Luzardo *et al.*, 2014);3.98 ug/kg(Abbassy, 2017);0.72-51.4 ug/kglipid (Chen *et al.*, 2018); 0.026-0.240 mg/kg fat (Sharm	0.018mg/kg (Bempah *et al.*, 2012b); 0.001-0.001 mg/kg (Koranteng *et al.*, 2017); 123.5 ug/kg (Oyeyiola *et al.*, 2017); Banana-0.005-0.062 mg/kg (Bempah *et al.*, 2012b);0-48.22 ug/kg (Forkuph *et al.*, 2018)	*al.*, 2016); Cabbage-0.0-1.52 ug/kg (Kolani *et al.*, 2016); 402 ug/kg (Bempah *et al.*, 2012a); 0.34-31.73ug/kg (Bolor *et al.*, 2018); 0.011-0.019 mg/kg (Bempah *et al.*, 2012b); 21.9ug/kg(Farina *et al.*, 2016);86.5 ug/kg (Oyeyiola *et al.*, 2017); 21.2 ug/kg (Olatunji, 2019); Lettuce-0.0-1.23 ug/kg (Kolani *et al.*, 2016); 186 ug/kg (Bempah *et al.*, 2012a); 4.51- 11.5 ug/kg (Bolor *et al.*, 2018); 0.043-0.087 mg/kg (Bempah *et al.*, 2012b); 4.5.8ug/kg(Farina *et al.*, 2016); 0.001-1.236 ug/kg (Bhatt *et al.*, 2019); 119.55 ug/kg(Aytenfsu *et al.*, 2016); 28.2 ug/kg(Olatunji, 2019); Carrot- 156 ug/kgt (Bempah *et al.*, 2012a);0.004-0.008 mg/	(Oyeyiola *et al.*, 2017); Millet-1.44 ug/kg (Oyeyiola *et al.*, 2017); Beans 106.5 ug/kg (Oyeyiola *et al.*, 2017) Cowpea -110.5 ug/ kg (Oyeyiola *et al.*, 2017)

		a *et al.*, 2020);0. 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) ; Onion-4.42 ug/kg(Bolor *et al.*, 2018); 0.046-0.071 mg/kg (Bempah *et al.*, 2012b); 0.003-0.0131 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

								(Farina *et al.*, 2016); 46.46ug/kg (Olatunji, 2019); Mustard 0.6 ug/kg (Farina *et al.*, 2016); Green peper 12.1 ug/kg (Oyeyiola *et al.*, 2017)
12	Deltamethrin	0.06-0.75 mg/L (Shahzadi *et al.*, 2013)	0.0579-0.80 mg/L (Shahzadi *et al.*, 2013)	0.07-0.60 mg/L (Shahzadi *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 -0.0-0.09mg/kg (Jallow *et al.*, 2017); atermelon-0.06-0.29 mg/kg (Jallow *et al.*, 2017);Peer-0.007-0.010mg/ kg(Bempah *et al.*, 2012b) Pineapple-0.026-0.062mg/ kg (Bempah *et al.*, 2012b); Banana-0.008-0.040 mg/kg Bempah *et al.*, 2012b)	Salad-0.0-0.021 mg/kg (Akomea-Frempong *et al.*, 2017); Lettuce-0.007-0.023 mg/kg Bempah *et al.*, 2012b); Cabbage-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)
13	Diazinon	0.0378 mg/kg (Jayasinghe *et al.*, 2019)			0.0155 mg/kg (Jayasinghe *et al.*, 2019)		Apple-0.0-0.08mg/kg (Jallow *et al.*, 2017); Strawberry-0.0-0.12 mg/kg (Jallow *et al.*, 2017); Pineapple-0.001-	Salad-0.0-0.184mg/kg (Akomea-Frempong *et al.*, 2017); Sweet peppers-0.00-0.066 mg/kg (Abdelbagi *et al.*, 2020);

		0.009mg/ kg (Bempah *et al.*, 2012b);	Tomato- 0.003-0.013 mg/kg(Bempah *et al.*, 2012b);0.05-0.109 mg/kg (Amrollahi *et al.*, 2018); Lettuce- 0.002-0.006 mg/ kg (Bempah *et al.*, 2012b); 3.8 ug/kg (Farina *et al.*, 2016); Cabbage- 0.010-0.019 mg/kg (Bempah *et al.*, 2012b);20ug /kg (Farina *et al.*, 2016); 0.009 mg/kg (Ramadan *et al.*, 2020);Carrot -0.003-0.011 mg/kg (Bhatt *et al.*, 2019); Cucumber- 0.003-0.011 mg/kg [(Bempah *et al.*, 2012b); 0.032-0.51 mg/ kg (Amrollahi *et al.*, 2018);Onion - 0.004-0.010 mg/kg(Bempah *et al.*, 2012b);Cauliflower-13.3 ug/kg (Farina *et al.*, 2016);Spinach 20ug/kg (Farina *et al.*, 2016); Mustard 1.1 ug/kg(Farina *et al.*, 2016);Chilli pepper- 0.013-0.026

14	Dichlorvos							mg/kg (Ramadan *et al.*, (2020) Cabbage-0.26 ug/kg (Qamar *et al.*, 2017)		
15	Dieldrin / Aldrin	0.006-0.018 mg/kg (Shaker *et al.*, 2015); 14.73 ug/kg fat (Bayat *et al.*, 2011); 2.08-18.45 ug/kg (Ishaq & Nawaz, 2018); 0.007 mg/kg fat(Kampire *et al.*, 2011);0.12-2.5 mg/kg fat(Kiranmayi *et al.*, 2018); 0.0074-0.0271 mg/kg fat (Aytenfsu *et al.*, 2016); 26 ug/kg d.w.(Raslan *et al.*, 2018); 1.57 ug/kg (Abbassy, 2017)	11.6 ug/kg (Deti *et al.*, 2014); 14 ug/kg dw .(Raslan *et al.*, 2018)	0.005 mg/kg fat (Kampire *et al.*, 2011)	0.98-14.73 ug/kg fat (Avancini *et al.*, 2013)	123 ug/kg d.w. (Ntow, 2001); 82 ug/kg d.w. (Elbashir *et al.*, 2015);1.76ug/ kg(Abbassy, 2017);0.01-4.22 ug/kg lipid (Kao *et al.*, 2019)	Papaya-0.002-0.040 mg/kg (Bempah *et al.*, 2012b); Pineapple-0.007-0.018mg/ kg (Bempah *et al.*, 2012b); Banana-0.013-0.203 mg/kg (Bempah *et al.*, 2012b); Mango-0.20 mg/kg (Qamar *et al.*, 2017); Watermelon-2.21ug/kg(Oyeyiola *et al.*, 2017); 0-22.8ug/kg (Forkuoh *et al.*, 2018)	Tomato: 0.0-0.457 ug/kg(Kolani *et al.*, 2016);0.002-0.040 mg/ kg (Bempah *et al.*, 2012b); 0.82ug/kg (Oyeyiola *et al.*, 2017)] Cabbage-0.0-0.438 ug /kg(Kolani *et al.*, 2016); 0.030-0.052 mg/kg (Bempah *et al.*, 2012b); 1.12ug/kg (Oyeyiola *et al.*, 2017); lettuce-0.0-0.390 ug/kg(Kolani *et al.*, 2016); 1.49-21.5 ug/kg (Bolor *et al.*,2018);0.006-0.012 mg/ kg (Bempah *et al.*, 2012b); 1.95ug/kg (Oyeyiola *et al.*, 2017); Onion-5.49-7.88 ug/kg (Bolor *et al.*, 2018); 0.004-0.008 mg/kg (Bempah *et al.*, 2012b); 0.008-0.011 mg/kg (Koranteng *et al.*, 2017); Cucumber-0.005-0.013 mg/kg (Bempah *et*	Maize-0.36 ug/kg (Oyeyiola *et al.*, 2017); Wheat 3.52 ug/kg (Oyeyiola *et al.*, 2017) ; Sorgum-2.40ug/ kg (Oyeyiola *et al.*, 2017); Millet-0.38 ug/kg (Oyeyiola *et al.*, 2017) ; Beans 3.62 ug/kg (Oyeyiola *et al.*, 2017); Cowpea-0.36 ug/kg(Oyeyiola *et al.*, 2017)	0.00092-0.00275 mg/kg(Bhinchhar *et al.*, 2018)

								al., 2012b);0.22 ug/kg (Oyeyiola *et al.*, 2017); Carrot-1.30 ug/kg (Oyeyiola *et al.*, 2017); Chilli pepper-2.03 ug/kg (Oyeyiola *et al.*, 2017); Greenpepeer -2.02ug/kg (Oyeyiola *et al.*, 2017)
16	Difenoc onazole						Gauva- 81.5 mg/kg (Hassine *et al.*, 2012)	Eggplant- 5.62 mg/ kg (Akhtar *et al.*, 2018); Round Gourd-61.53 mg/kg (Akhtar *et al.*, 2018; Sweet peppers- 0.115-0.248 mg/kg (Abdelbagi *et al.*, 2020);Leafy vegetables- 0.0-0.08 mg/kg(Elgueta *et al.*, 2017)
17	Dimeth oate	0.111- 0.167mg/kg (Steingrímsdóttir *et al.*, 2018);0.120 mg/kg (Jayasinghe *et al.*, 2019)			0.0205mg/kg (Jayasinghe *et al.*, 2019)		Papaya- 0.002-0.012 mg/kg (Bempah *et al.*, 2012b); 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); Lettuce- 0.018-0.024 mg/kg(Bempah *et al.*,2012b);3.55 ug/kg (Farina *et al.*,2016); Carrot- 0.018-0.024 mg/ kg(Bempah *et al.*, 2012b); Onion- 0.002-0.008

								mg/kg(Bempah *et al.*, 2012b); Cabbage 7.2 ug/ kg (Farina *et al.*,2016); 0.560 mg/kg (Jayasinghe *et al.*, 2019); Cauliflower 7.4ug/kg (Farina etal. 2016); spinach 26.6ug/kg(Farina *et al.*,2016); Broccoli- 20 ug/kg (Farina *et al.*, 2016) ; Mustard 5.8 ug/kg (Farina *et al.*,2016); Okara- 0.058 mg/kg (Sah *et al.*, 2018)		
18	Dimethomorph						Gauva- 0.48 mg/kg (Akhtar *et al.*, 2018)	Eggplant- 0.25 mg/ kg kg (Akhtar *et al.*, 2018) Round Gourd-0.15 mg/kg kg (Akhtar *et al.*, 2018)		
19	Endosulfan	4.65-545 ug/kg(Ishaq & Nawaz, 2018); 0.002 mg/kg fat (Kampire *et al.*, 2011); 0.006 mg/kg (Kiranmayi *et al.*, 2018);0.0-27.6 ug/kg (Bedi *et al.*, 2015); 0.0-130 ug/kg (Gill *et al.*, 2020)	47.8 ug/kg (Deti *et al.*, 2014)	142.1 ug/kg (Bempah *et al.*, 2012a)	0.28-12.2 ug/kg fat (Avancini *et al.*, 2013)	0.0155-5.43ug/ kg lipid(Chen *et al.*, 2018); 0.0-5.45 ug/kg lipid (Kao *et al.*, 2019)	Watermelon -0.06 mg/kg (Hadian *et al.*, 2019);0.29ug/ kg(Oyeyiola *et al.*, 2017)	Cabbage- 28.47 ug/kg (Bolor *et al.*,2018); 10 ug/kg(Farina etal. 2016); 0.312 mg/kg (Sah *et al.*, 2018);0.17ug/kg (Oyeyiola *et al.*, 2017) ; Lettuce- 0.6-4.10 ug/kg (Bolor *et al.*, 2018); 7.0 ug/kg(Farina *et al.*,2016); 0.28ug/kg(Oyeyiola *et al.*, 2017); Onion-1.54-	Maize- 0.08 ug/ kg(Oyeyiola *et al.*, 2017); Wheat 0.08 ug/kg(Oyeyiola *et al.*, 2017);Sorgum- 0.06ug/ kg(Oyeyiola *et al.*, 2017); Millet- 0.08 ug/kg(Oyeyiola	0.0-38.6 ug/kg (Bedi *et al.*, 2015); 0.40-1.2 ug/kg (Koli & Bhardwaj, 2018) ; 0.00074-0.00333 mg/kg (Bhinchhar *et al.*, 2018)

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); 0.16ug/kg (Oyeyiola *et al.*, 2017);Chilli pepper- 0.002-0.012 mg/kg (Koranteng *et al.*, 2017); 0.29ug/kg (Oyeyiola *et al.*, 2017); Cucumber- 0.10 mg/kg (Hadian *et al.*, 2019);0.08 ug/kg (Oyeyiola *et al.*, 2017);Caulif lower 10ug/ kg (Farina *et al.*,2016); 0.943-2.870 mg/kg (Sah *et al.*,2018); Spinach 7.3ug/kg (Farina *et al.*, 2016);Brocc oli- 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);Caulif	*et al.*, 2017); Beans 0.08 ug/kg(Oyeyiola *et al.*, 2017); Cowpea -0.07 ug/ kg(Oyeyiola *et al.*, 2017)

							lower-0.378mg/kg (Sah *et al.*, 2018);Carrot -0.08 ug/kg (Oyeyiola *et al.*, 2017); Greenpepper - 0.27ug/kg (Oyeyiola *et al.*, 2017)
20	Fenpropathrin					Strawberry-0.0-1.2 mg/kg (Jallow *et al.*, 2017); Papaya-0.018-0.021 mg/kg(Bempah *et al.*, 2012b); Mango-0.006-0.014 mg/kg Bempah *et al.*, 2012b); Watermelon -0.013-0.021 mg/kg Bempah *et al.*, 2012b)	Tomato-0.04 mg/kg (Hadian *et al.*,2019); 0.485 mg/kg (Bhatt *et al.*, 2019); Cluster beans-0.401 mg/kg (Bhatt *et al.*, 2019); Brinjal 0.389 mg/kg (Bhatt *et al.*, 2019)
21	Fenvalerate	0.0-34.5ug/kg (Bedi *et al.*, 2015]					Salad-0.0-0.05mg/kg (Akomea-Frempong *et al.*, 2017); Tomato-0.010-0.016 mg/kg(Bempah *et al.*, 2012b);0.05 mg/kg (Hadian *et al.*, 2019); Cabbage-0.003-0.017 mg/kg (Bempah *et al.*, 2012b);11.8 ug/kg (Farina *et al.*, 2016); 0.0-0.560 mg/kg(Sah *et al.*, 2018); Carrot-0.004-0.008 mg/kg

							(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)	
22	Fipronil	0.190mg/kg (Jayasinghe *et al.*, 2019); 0.0-110ug/kg (Gill *et al.*, 2020)		0.086 mg/kg (Jayasinghe *et al.*, 2019)				
23	HCB	0.019-0.033 mg/kg(Shaker *et al.*,2015); 0.027 mg/kg (Kiranmayi *et al.*, 2018); 0.016 mg/kg fat (Aytenfsu *et al.*, 2016)		0.007 mg/kg fat (Aytenfsu *et al.*, 2016)				
24	Hepatchlor	0.002-0.60		1.22-6.02 ug/kg	0.0728-5.01ug/	Watermelon -0.001-0.027	Lettuce-0.20-2.30	Maize-1.68ug/

		mg/kg (Kiranmayi *et al.*, 2018);			fat(Avancini *et al.*, 2013)	kg lipid (Chen *et al.*, 2018); 0.0-5.01 ug/kg lipid(Kao *et al.*,2019); 0.08-0.14 mg/kg fat(Al Antary *et al.*, 2015);	mg/kg(Koranteng *et al.*,2017) ; 0.8 ug/kg (Oyeyiola *et al.*,2017)	ug/kg(Bolor *et al.*, 2018); 0.001-0.254 ug/kg (Kolani *et al.*,2016); 0.72 ug/kg(Oyeyiola *et al.*, 2017);Onion -0.90ug /kg (Bolor *et al.*, 2018); Sweet peppers- 0.030-0.069 mg/ kg(Abdelbagi *et al.*, 2020); Cabbage- 0.001-0.248 ug /kg (Kolani *et al.*, 2016); 1.0ug/kg(Oyeyiola *et al.*, 2017); Carrot- 0.72 ug/ kg (Oyeyiola *et al.*, 2017); Tomato- 0.68 ug/kg (Oyeyiola *et al.*,2017); Cucumber- 1.16ug/kg (Oyeyiola *et al.*,2017); Chilli pepper- 0.82 ug/kg (Oyeyiola *et al.*, 2017); Green pepper- 0.7ug/kg (Oyeyiola *et al.*,2017)	kg (Oyeyiola *et al.*,2017) ; Wheat 1.24ug/ kg (Oyeyiola *et al.*,2017); Sorgum - 1.26ug/ kg (Oyeyiola *et al.*,2017); Millet- 1.32 ug/kg (Oyeyiola *et al.*,2017)]; Beans 1.1 ug/kg (Oyeyiola *et al.*,2017); Cowpea -2.7 ug/ kg (Oyeyiola *et al.*,2017)]
25	Imidacloprid	0.111-0.99 mg/kg (Shahzadi *et al.*, 2013)	0.10-0.41 mg/kg(Shahzadi *et al.*, 2013)	0.04-0.80 mg/kg(Shahzadi *et al.*, 2013)			Gauva- 1.65 mg/kg(Akhtar *et al.*, 2018); Apple-0.2-0.65 mg/kg (Jallow *et al.*,2017); Grapes-0.0-0.98 mg/kg (Jallow *et*	Tomato- 0.0-0.51 mg/kg (Jallow *et al.*,2017); 0.043-0.116 mg/kg (Ramadan *et al.*, 2020); Eggplant- 0.0-0.09mg/ kg (Jallow *et*	

							al.,2017); Strawberry-0.0-0.2 mg/kg (Jallow *et al.*,2017)	*al.*,2017); 0.045mg/kg (Ramadan *et al.*,2020); Cucumber-0.05-1.2mg/kg (Jallow *et al.*,2017);0.071-0.199 mg /kg(Ramadan *et al.*, 2020); Leafy vegetables-0.02-0.18 mg/ kg(Elgueta *et al.*,2017) ;Cabbage-0.014-0.051 mg / kg Ramadan *et al.*, 2020); Onion-0.019-0.053mg/ kg (Ramadan *et al.*, 2020); Potato-0.031-0.076 mg/kg Ramadan *et al.*, 2020);
26	Larvin	67 ug/kg (Dahshan *et al.*, 2016)						
27	Lindane	0.090-0.192 mg/kg(Ayoub *et al.*, 2012);0.026 mg/kg fat (Kampire *et al.*,2011) ; 0.0-17.8 ug/kg (Bedi *et al.*,2015); 0.0-85 ug/kg (Gill *et al.*,2020)		0.022 mg/kg fat(Kampire *et al.*,.2011)			Papaya-0.092-0.105 mg/kg (Bempah *et al.*, 2012b); Mango-0.006-0.022 mg/kg (Bempah *et al.*, 2012b); Peer-0.006-0.012 mg/kg (Bempah *et al.*, 2012b); Pineapple-0.121-0.153 mg /kg(Bempah *et al.*, 2012b); Watermelon-0.004-0.006 mg/kg	Carrot-220 ug/kg(Bempah *et al.*, 2012a); Cabbage-196 ug/kg(Bempah *et al.*, 2012a);0.095-0.102 mg/ kg(Bempah *et al.*, 2012b)]; Lettuce-24 ug/kg(Bempah *et al.*, 2012a);0.004-0.006 mg/kg(Bempah *et al.*, 2012b);Tomato-27ug/ kg (Bempah *et*

			(Bempah *et al*., 2012b)	*al*., 2012a); 0.004-0.010 mg/kg (Bempah *et al*., 2012b); Onion 0.016-0.020 mg/ kg(Bempah *et al*., 2012b); Okra4.837 mg/kg (Bhatt *et al*.,2019); Brinjal0.917 mg/kg(Bhatt *et al*.,2019); Chillipepper -2.126 mg/ kg(Bhatt *et al*.,2019)
28	Malathion	0.188-0.989(Shaker &Elsharkawy, 2015);0.0-34.6 ug/kg(Bedi *et al*., 2015)	Apple- 0.09-0.58 mg/kg (Jallow *et al*.,2017); Strawberry-0.0-0.98 mg/kg (Jallow *et al*.,2017) [50]; Papaya-0.002-0.006 mg/kg (Bempah *et al*., 2012b); Pineapple-0.002-0.008 mg/kg(Bempah *et al*., 2012b)	Tomato-0.005-0.062 mg/kg(Bempah *et al*., 2012b); Lettuce-0.001-0.006 mg/kg(Bempah *et al*., 2012b);6.6 ug/ kg (Farina *et al*., 2016); Cabbage-0.004-0.008 mg/kg(Bempah *et al*., 2012b); 4 ug/kg(Farina *et al*., 2016); 0.279 mg/kg (Sah *et al*.,2018); 0.007-0.013 mg/kg (Ramadan *et al*., 2020); Carrot-0.005-0.011 mg/kg (Bempah *et al*., 2012b);Cucumber-0.008-0.0121mg/kg (Bempah *et al*., 2012b); 0.011-0.273

								mg/kg (Ramadan *et al.*, 2020); Okra-0.713 mg/kg (Sah *et al.*, 2018); Eggplant-0.009-0.013 mg/kg (Ramadan *et al.*, 2020)
29	Methamidophos					0.0-13.2 ug/L (Smadi *et al.*,2019)		
30	Methomyl	325 ug/kg (Dahshan *et al.*, 2016)						Leafy vegetables-0.01-0.02 mg/kg(Elgueta *et al.*,2017);Cauliflower 0.9 ug/kg(Farina *et al.*,2016);Spinach6.0ug/kg(Farina *et al.*,2016);Broccoli-11 ug/kg(Farina *et al.*,2016);Mustard-6.4ug/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-

								0.054 mg/kg(Ramadan *et al.*,2020);Eggplant-0.008 -0.307 mg/kg(Ramadan *et al.*,2020);Potato- 0.005 - 0.010 mg/kg(Ramadan *et al.*,2020)
31	Methoxychlor	0.137-0.198mg/kg (Shaker &Elsharkawy, 2015);24.99 ug/L(Bulut *et al.*, 2011); 0.018 mg/kg (Kiranmayi *et al.*, 2018);0.0-40 ug/kg(Gill *et al.*, 2020)]				0.0245-0.618 ug/kg lipid (Chen *et al.*, 2018);0.0-0.62 ug/kg lipid (Kao *et al.*, 2019)	Papaya-0.004-0.012mg/kg (Bempah *et al.*, 2012b);Mango-0.004-0.006 mg/kg(Bempah *et al.*, 2012b) ; Peer-0.00 mg/kg(Bempah *et al.*, 2012b); Pineapple-0.007-0.052 mg/kg(Bempah *et al.*, 2012b); Banana - 0.004-0.012 mg/kg(Bempah *et al.*, 2012b)]	Cabbage-9.02-184.1 ug/kg (Bolor *et al.*,2018); 0.022-0.031 mg/kg (Bempah *et al.*, 2012b); Lettuce-57.75-165.2 ug/ kg(Bolor *et al.*, 2018); 0.022-0.031 mg/kg (Bempah *et al.*, 2012b); Onion-88.3-160.96 ug/kg (Bolor *et al.*,2018); 0.025-0.066 mg/kg (Bempah *et al.*, 2012b); 0.001-0.062 mg/kg(Koranteng *et al.*, 2017); 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); Chilli pepper-0.051-0.057

							mg/kg (Koranteng *et al.*, 2017)
32	Monocrotophos					Watermelon 0.0-0.02 mg/kg (Hassine *et al.*,2014)	Tomato-0.0-0.02 mg/kg (Jallow *et al.*, 2017); Cucumber-0.0-0.04 mg/kg (Jallow *et al.*, 2017)
33	Omethoate						Sweet peppers-0.607-1.31 mg/kg(Luzardo *et al.*, 2014)
34	Oxamyl						Tomato- 0.0-0.09 mg/kg (Hassine *et al.*, 2014); Cucumber-0.0-0.98mg/kg (Hassine *et al.*, 2014)
35	Oxyfluorfen	0.0239 mg/kg (Jayasinghe *et al.*,2019)		0.02225 mg/kg (Jayasinghe *et al.*,2019)			
36	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)]
37	Parathion-methyl/ Parathion-ethyl	0.001-0.002(Shaker &Elsharkawy, 2015)				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 9.9ug/kg (Farina *et al.*,2016); Lettuce 3.5 ug/kg(Farina *et al.*,2016); Spinach 7.9ug/kg(Farina *et al.*, 2016);Broccoli- 21.3 ug /kg(Farina *et al.*,2016); Mustard-10.06ug/kg (Farina *et*

							al.,2016); Brinjal- 0.102 mg/kg (Bhatt *et al.*, 2019)
38	Perfinofos	0.0006-0.004 mg/kg(Sajid *et al.*, 2016)	0.0013-0.0025 mg/kg (Sajid *et al.*, 2016)				
39	Permethrin	0.033-0.042 mg/kg (Sajid *et al.*, 2016); 0.31-650 ug/kg (Gill *et al.*, 2020)	0.042-0.045 mg/kg(Sajid *et al.*, 2016)]			Papaya-0.005-0.032mg/kg (Bempah *et al.*, 2012b); Mango-0.002-0.012 mg/kg[(Bempah *et al.*, 2012b); Peer-0.004-0.008 mg/kg(Bempah *et al.*, 2012b)]; Pineapple-0.025-0.066 mg/kg(Bempah *et al.*, 2012b)	0.033-0.042 mg/kg (Sajid *et al.*, 2016); Tomato-0.69-29.06 mg/kg(Kariathi *et al.*,2016); 0.14 mg/kg (Hadian *et al.*,2019); 0.005-0.032 mg/kg (Bempah *et al.*, 2012b) ; 0.66-1.51 mg/kg (Amrollahi *et al.*,2018); 0.610 mg/kg(Bhatt *et al.*, 2019);Salad-0.0-0.460 mg /kg(Akomea - Frempong *et al.*, 2017); Lettuce-0.025-0.080 mg/kg (Bempah *et al.*, 2012b);1.3 ug/kg(Farina *et al.*,2016); Cabbage-0.022-0.078mg/ kg (Bempah *et al.*, 2012b); 6.2 ug/kg(Farina *et al.*, 2016); Carrot-0.03-0.052 mg/kg(Bempah *et al.*, 2012b);

							Cucumber-0.003-0.009 mg/kg(Bempah *et al.*, 2012b); 0.56-0.96 mg/kg(Amrollahi *et al.*, 2018);Leafy vegetables-0.0-1.45mg/kg (Elgueta *et al.*,2017);Cauliflower7.9 ug /kg (Farina *et al.*,2016); Spinach4.9ug/kg(Farina *et al.*,2016);Broccoli-6.3ug/ kg (Farina *et al.*,2016); Mustard 4.7 ug/kg(Farina *et al.*,2016)
40	Phenoate	0.101 mg/kg (Jayasinghe *et al.*,2019)		0.0364mg/kg (Jayasinghe *et al.*,2019)			
41	Profenofos	0.196 mg/kg (Jayasinghe *et al.*,2019) ; 0.25-74 ug/kg(Gill *et al.*, 2020); 1.96 ug/kg (Abbassy, 2017)		0.003mg/kg (Jayasinghe *et al.*, 2019)	2.66 ug/kg (Abbassy, 2017)	Papaya-0.001-0.005 mg/kg (Bempah *et al.*, 2012b)	Tomato-0.02-0.39mg/ 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); Cabbage-0.002-0.010 mg/kg(Bempah *et al.*, 2012b); 0.007-0.496 mg/kg(Ramadan *et al.*, 2020)];Carrot-0.010-0.016 mg/kg (Bempah *et al.*, 2012b);

								Cucumber-0.001-0.009 mg/kg (Bempah *et al.*, 2012b) ; Onion-0.008-0.044mg/kg (Bempah *et al.*, 2012b); Chilli pepper-0.007-0.041 mg/kg(Ramadan *et al.*, 2020)
42	Prothiofos	0.0568 mg/kg (Jayasinghe *et al.*,2019)]						
43	Tebuconazole	0.062 mg/kg(Jayasinghe *et al.*,2019)						Cucumber-0.091-0.159 mg/kg (Ramadan *et al.*, 2020);Chilli pepper-0.017 mg/kg (Ramadan *et al.*, 2020);Potato -0.011-0.039 mg/kg (Ramadan *et al.*, 2020)
44	Organochlorine pesticides	133.38 ug/L (Bulut *et al.*, 2011); 26.04 ug/kg fat (Santos *et al.*, 2015); cheese 26.14ug/kg fat(Santos *et al.*, 2015); 7.58 ug/kg(Abbassy, 2017)		243.81ug/L (Bulut *et al.*, 2011)		12.44 ug/kg(Abbassy, 2017)	Orange-0.006-0.012mg/kg (Smadi *et al.*, 2019)	Cabbage-0.006-0.14 mg/kg (Smadi *et al.*, 2019) ;Tomato-0.006-0.013mg/ kg (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.

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