Al-Kufa University Journal for Biology / VOL.14 / NO.2 / Year: 2022
Print ISSN: 2073-8854 Online ISSN: 2311-6544

Review of studies that deal with the Physiological effects of pesticides on some animals in Iraq

Enas Hussein Ali[1]
Khamaal Hussein Abod Al-Khafaji[2]
Nagham Abdul Ghani Mohammad[3]
Ali Hassan Abood[4]
[1,4]Iraq, Ministry of Higher Education and Scientific Research, University of Kufa, Faculty of Science
[2,3]Iraq, Ministry of Higher Education and Scientific Research, University of Kirkuk, College of Pharmacy
Corresponding author: inas.aldaffaie@uokufa.edu.iq

Abstract

All substances used to eliminate or manage pests are collectively referred to as "pesticides," including insecticides (insecticides), fungicides (fungi), and herbicides (weedicides). One of the main supporters of the green revolution sought ways to improve and utilized suitable pesticides to control the wide range of insect and plant pests that have a detrimental impact on the quantity and quality of the world's food supply. This review looks at pesticide categories, toxicity, deciding variables, pesticides in water supplies, contaminated soils, impacts on human health, and techniques for detection, removal, and repair. Furthermore, this essay contrasts the analytical techniques used to measure the very low concentrations of pesticides, as well as gives a concise overview of the separation procedures utilized for pesticide examination. Finally, our research suggests that new technologies for detecting pesticide residues and other very harmful pollutants be developed. Both severe, or simple, and persistent, or hard, unfavorable health effects can arise from the use of pesticides, and they can manifest months or years after administration. The goal of this project is to demonstrate the detrimental effects of chemical pesticides, as well as their repercussions on the environment and people's health in Iraq. We could conclude that incorrect use of these substances might be harmful in the short- or long-term. Governmental agencies in charge of these materials should pursue alternate control strategies to decrease the danger and abuse of these compounds. Taking into account that educating the public about the dangers of pesticides is a crucial part of preserving improved both the environment and health in Iraq, that might be better and have no adverse effect on health and the environment.

Keywords: Pesticide, contamination, human influence.

Introduction

Pesticides are extensively utilized in most areas of agricultural production to eliminate or decrease pest costs, and so can increase output and product quality, including cosmetic appeal, which is often essential to users. Intake of pesticides results in approximately 150,000 fatalities annually. Ingesting personality is the most common cause of death. instead of industrial or unintentional infections, which primarily involve skin contact or inhalation. Because pesticides are frequently used in small-scale agriculture and are therefore widely accessible, pesticide toxicity is particularly significant in some regions of low- and middle-income countries. (1, 2). 70 percent of these deaths could be attributed to pesticide exposure at work. Furthermore, consistent exposure to lessen pesticide doses was connected to several disorders in the medium and long term, including a variety of cancers and nervous

system problems (3). Compounds used in animal farming and agriculture, such as nutrients, timing and acidifying reagents, soil amendment, insecticides, and soil amendment (antibiotics and hormones) are a prevalent international practice (4). Pesticides run the risk of contaminating the ground, the water supply, the grass, and other plant life. In addition to killing weeds and insects, pesticides can be harmful to a range of animals, fish, beneficial insects, and non-target plants. Herbicides can also affect organisms that are not intended targets, even though insecticides are the most dangerous sort of pesticide (5). Residues of persistent pesticides and other harmful compounds have been identified in animal products such as milk and meat. Contaminated feed and fodder are the main sources of these chemicals entering the animal body. It will be extremely difficult to avoid contamination in milk and meat unless the residues are controlled at this stage (6). Pesticides are inhaled by humans as a result of their jobs or by exposure to food and the environment (water, soil, air). Questions have been raised about how environmental factors affect the prevalence of human illnesses for numerous years. The present state of knowledge about the possible harm endocrine disrupting pesticides could do to people's health is reviewed in this paper (7).

Pesticides in Common utilize

To classify pesticides, experts utilize terms such as functional groups, chemical categories, modes of action, and toxicity. (8). Starting, pesticides are categorized according to the pests they are meant to control, such as fungicides, insecticides, herbicides, and rodenticides. For instance, fungicides are used to eradicate fungi, insecticides to eradicate insects, and herbicides to eradicate weeds (9, 10). Chemically speaking, pesticides are separated into organic and inorganic substances. Among inorganic pesticides include copper sulfate, copper, ferrous sulfate, lime, and sulfur. Organic insecticides have more advanced ingredients (11). Chlorohydrocarbon insecticides, carbamate insecticides, organophosphorus insecticides, hormone analog herbicides, synthetic urea herbicides, benzimidazole nematocides, triazine herbicides, and D group vitamin-based rodenticides are some examples of organic. (12). Different forms of pesticides have provided enormous primary benefits across several fields, including agriculture and public health (13). In terms of public health, pesticides are used in homes, offices, malls, and streets to kill pests such as mosquitoes, ticks, rats, and mice. This has greatly decreased or abolished the massive burden of diseases caused by these vectors (14).

Contamination of Pesticide

Despite their significant contribution to increasing agricultural production, pesticides, and producing affordable, high-quality food, their widespread usage has several detrimental consequences on the environment and human health (15).

Human health risks are undervalued

Although the impact of pesticide use is generally undiscovered, farmers, their families, and those who live close to farming areas may experience long-term health problems, according to the data. hazards as a result of pesticide use. In this study, the impact of elevated amounts of pesticide exposure while pregnant was investigated in a residential area with a predominance of agriculture leading to an increase in bad birth outcomes (16). Pesticides are connected to "a wide spectrum of oncological (cancer), hematological morbidity, and pulmonary dysfunction, as well as immune system inadequacies and inborn abnormalities," based on the report. Farmworkers are exposed to considerable risks of infected area poisoning and inhalation when handling

and treating pesticides to plants. The eating of shellfish and fish that have been poisoned by the persistence of fish that reside at the bottom of the primary submerged agricultural portions is the first of two primary consequences on human health caused by pesticide runoff in water. The second is pesticide-contaminated water that is directly consumed (17, 18). Dichlorodiphenyltrichloroethane, or DDT, is the most well-known organochlorine pesticide, and numerous issues with human health and the environment were brought about by its unrestrained use. The insecticides dieldrin, endosulfan, heptachlor, dicofol, and methoxychlor are other examples of organochlorines in use. (19, 20). In certain nations, DDT is continuing in use or is being reintroduced for public health purposes. (21). DDT is also employed as a solvent-free solution in several solvents. It is a prevalent chemical, and it is believed that every living thing on the globe has a body load of DDT, which is primarily stored in fat. (22). It has also been demonstrated that DDT and its metabolite p,p-dichlorodiphenyldichloroethylene (DDE) have endocrine-disrupting and carcinogenic characteristics. The effects of DDT and DDE exposure during pregnancy on children's neurodevelopment have been connected. (23). Organochlorine insecticides in general have been linked to health problems such as endocrine abnormalities (24), embryonic development impacts (25), metabolism of lipids (26), and changes in hematology and hepatic function (27). Although their malignant ability is debatable, concerns concerning known cancer-causing actions should not be dismissed (28).

Organophosphate pesticides comprise several different pesticides, one of which, is glyphosate, which is significantly more common and was promoted as an environmentally acceptable substitute for organochlorines. Malathion, parathion, and dimethoate are other well-known pesticides in this class, several of which have been connected to endocrine damage (29), this class of insecticides has been connected to changes in cholinesterase enzymatic activity (30), insulin secretion is reduced, and normal cellular metabolism of proteins, carbs, and lipids is disrupted (26), also causing genotoxicity (31). and impacts mitochondrial activity, causing cellular oxidative stress, neurological problems, and endocrine system issues (26).

Organophosphorus pesticide exposure has been related to significant health consequences, it also includes cardiovascular illness, according to population-based research (32). Moreover, prenatal organophosphate is possibly related to shorter gestational periods and neurological abnormalities in kids (33, 34).

Pesticides containing carbamates, Ziram, carbofuran, and aldicarb, among others, have also been connected to endocrine alteration (35), as well as the consequences for cellular metabolic systems and mitochondrial function (26). Furthermore, carbamate insecticides have been shown to promote immune cells in humans undergoing apoptosis and necrosis. (36), naturally occurring killer cells (37), and the T lymphocytes in additional investigations (38).

Pesticide effects on farmed animals

A new study reveals that farmers who worked with various French livestock and crops were subjected to pesticides are more likely to develop Parkinson's disease, and It adds to the growing body of information showing a connection between Parkinson's disease and the herbicides diquat and paraquat as well as rotenone and dithiocarbamate fungicides (39, 40). Pesticide exposure is considered to be a factor in the increased number of central nervous system tumors seen in farmers, however, research on specific pesticides is sparse. Some experimental investigations have found evidence of carcinogenicity with carbamate insecticides, which are used on a wide

range of crops. We investigated the links between probable carbamate pesticide exposure and the occurrence of central nervous system tumors in the AGRICAN (AGRIculture & CANcer) cohort, both generally and by histological subtype (41).
Since 1974, glyphosate has been used in agriculture as a non-specific systemic pesticide. The herbicidal impact of glyphosate is explained by research as being mediated by 5-enolpyruvylshikimate-3-phosphate synthase. Aromatic amino acids are considered necessary elements that must be provided in the diet because this enzyme does not occur in the cells of humans and other vertebrates. The research demonstrates that glyphosate use in crops fed to poultry and cattle has had no effect on animal health, rumen/gut bacteria, or production, and that meat, milk, and eggs are safe to ingest (42).

Pesticide impacts on other animals

Diazinon caused a significant reduction in body weight. In the exposed rabbits, varying degrees of detrimental changes in the histological structure of the kidney were observed depending on the length of action of the used diazinon. It was established that diazinon induces a decrease in total carbs in kidney tissues and that this impact is linked to organophosphate content (43).

Of all the triazine herbicides, atrazine has received the most research. In mice and rats, the authors looked into their cancer-causing potential. Tumor incidence did not increase in mice, however, atrazine appeared to elevate the rate of breast cancer in Sprague-Dawley rats (44). Triazines are thought to be teratogenic and carcinogenic, but there is currently no evidence to support these claims. Neuromotor polyneuropathy can also be caused by atrazine pollution (45). Nanopesticides or nano plant protection products are an emerging technological development in terms of new technologies. These methods could provide several advantages in terms of pesticide utilization, including greater efficacy and longevity, as well as a reduction in the number of active substances employed (46). Nanopesticides are made up of "either very small particles of a pesticide active ingredient or other small designed structures with pesticidal characteristics" (47). In the nanoscale size range, in nanoformulations, various surfactants, organic polymers, and metal nanoparticles are combined (inorganic) (48). Synthetic pyrethroids are much less lasting and hazardous to vertebrates than natural pyrethroids. One of the pyrethroids that have gained widespread acceptance is deltamethrin. Despite this, this pyrethroid has impacts on fish's neurological, pulmonary, and blood systems, as well as tumorigenicity in rats and mice (49). All of these side effects are caused by oxidative stress, which affects a variety of antioxidants (50).

Effect of pesticides on earthworms

Earthworms are essential to the operation of the ecological system and the preservation of soil fertility. However, several pesticides used in agriculture around the world, such as imidacloprid, benomyl, and metribuzin, may be harmful to earthworms. However, pesticides had a considerable negative influence on bacterial biodiversity even when The pesticide concentration was far less than the earthworms' acute and long-term toxicity values. These findings showed that earthworms' gut microbiota were extremely susceptible to pesticide exposure in the soil. As a result, these tests should be included in pesticide risk assessment methods (51).

Effect the pesticides on Fish

Pesticide contamination of lakes and rivers has been observed all around the world (52,53), agriculture, and to a smaller degree, urban sources have been blamed for the majority of the increase (54). Insecticides, fungicides, and especially pyrethroid insecticides, and pesticide combinations, constitute a risk to fish's health and can produce direct potential toxicity at environmental concentrations, according to the study. Responsive developmental processes of species with highly specific life history features are possibly quite sensitive; nevertheless, a comprehensive assessment across species is currently impossible due to a paucity of toxicity data for non-model species (55). The study found that pesticides such as Chlorfenapyr, Dimethoate, and Acetamiprid have negative effects on a variety of hormonal, haematological, and histopathological biomarkers in freshwater fish It is stated that the parameters investigated in this study can be employed as diagnostic markers of pesticide poisoning in fish and other marine creatures in the area of natural biomonitoring (56).

Effect the pesticides on the environment

Pesticides are employed to get rid of insects and pests that ruin crops. Pesticides of all kinds have long been used to safeguard crops. Although pesticides are useful for crops, they have a major adverse impact on the ecology. The biodiversity may be destroyed by the overuse of pesticides. Hazardous substances are a threat to the existence of many bird species, aquatic species, and other animals. Pesticides endanger the stability of the world and the long-term viability of the environment (57). Pesticides may contaminate turf, water, soil, and other plant life. In addition to harmful insects and weeds, pesticides can be harmful to a range of animals, including birds, fish, beneficial insects, and non-target plants. Herbicides can also affect organisms that are not intended targets, even though insecticides are the most dangerous sort of pesticide (58). Plants and animals absorb a major portion of pesticide agricultural inputs, while microbial and chemical mechanisms destroy the rest. Moreover, by air movement, leaching, and operation, a significant portion of the amount sprayed is spread into the environment, where it is found in soils, surfaces, and water tables. The soil, water, grass, and other plant life could all be contaminated by pesticides. Various animals, such as birds, fish, and reptiles, can be harmed by pesticides and pollinating insects, in addition to destroying insects and weeds. The loss of biodiversity occurs as a result of repeated iterations. Many pesticides are difficult to degrade; they remain in the soil, leak into coastal aquifers, and pollute the ecosystem. They can bio-absorb into the body and concentrate in food chains., and so have an impact on the environment, according to their chemical qualities (59).

Residues of pesticides in the food supply

Water and soil pollution, as well as the poisoning of crops, fruits, milk, foodstuffs, and other living species, are the most significant impacts of synthetic pesticides, particularly organophosphate pesticides (60). Caused by human activity pollution, such as home and industrial discharges, fertilizer and pesticide applications, and soil degradation as a result of natural processes, are all major causes of pollution, Immediate interaction with the substance in production, synthesis, including using can also cause this (61). Pesticides, as well as other non-chemical solutions, are an effective and efficient way to resolve the problems in food production, whether traditional or natural. The overall use of pesticides has remained virtually stable since

the mid-1980s, thanks to advances in farming techniques. Before the information is examined by the Environmental Protection Agency, novel pesticides are subjected to extensive health testing and analysis by manufacturers. The Environmental Protection Agency risk assessments establish the levels that can be taken by people of all ages without causing detrimental health effects (62).

Pollution and toxicity are two issues with pesticides.

Toxicology of pesticides and other specific chemicals on non-target animals is already a major concern on a global scale. Pesticides can cause a variety of metabolic reactions once inside the body, rendering the search for pathways of toxicity considerably more difficult than predicted. The mechanism of action of pesticides may be one of the most effective techniques for determining the reasons for their toxic impacts. By interacting with hormones or messages produced by the body, pesticides can have negative consequences (63), the neurological system is affected (e.g. organochlorine) (64), and the research yielded a scientific explanation of the cause and effect between pesticides and human chronic illnesses caused by DNA damage (65). Animal experiments are still a useful technique for discovering serious tumor risks in humans. However, research results indicating an increased frequency of hematological malignancies in a variety of species and through various channels are considered sufficient proof that material causes cancer in test animals (64).

Pesticides' Advantages

The major advantages of pesticides are their adverse effects, which are the anticipated immediate advantages of their use. The impact of destroying caterpillars feeding on the product, for example, has the major potential of improving vegetable yields and improving quality. The fundamental benefits of the main effects range from the preservation of recreational grass to the saving of human lives. The secondary advantages are those that arise from the main benefits but are less immediate or visible. Higher vegetable yields, for instance, might provide more money that could be used to pay for children's education or healthcare, leading to a population that is healthy and better educated. Observed secondary benefits typically include healthier individuals and animal preservation (58). To get rid of pests, pesticides are utilized in streets, malls, residences, and businesses such as insects, fleas, rodents, and mice. As a result, the enormous burden of disease generated by these pathogens has been minimized or abolished (11, 66). Furthermore, pesticides are required in farm yields. Agriculture has employed pesticides to manage weeds and insects in agricultural operations, and the usage of pesticides has resulted in significant increases in agricultural goods (67). As a result, pesticides serve a key role in lowering illnesses and increasing agricultural output around the world. As a result, they have made a considerable role in tackling hunger and increasing access to powerful food (68).

Conclusion

Pesticides have grown in popularity for agricultural, commercial, animal grazing, and domestic usage, yet they pose a considerable hazard to health and cattle health. Organic farming is a more effective and profitable way to address pesticide residual issues. Other methods of preventing the negative effects of residues on the environment include developing regulatory standards and pesticide control measures. Agricultural productivity has a long and illustrious history in several parts of the

world. There are three stages in the evolution of pesticide use throughout agricultural production. chemical categories, functional groupings, action mechanisms, and Pesticides are categorized using a variety of terms, including toxicity. Pesticides have provided numerous advantages in many sectors, such as the improvement of the healthcare system and agriculture. Pesticides are utilized in homes for health care, offices, malls, and roads to kill pests such as insects, fleas, rodents, and mice. Finally, the enormous impact of diseases brought on by these carriers has been significantly eliminated. Workers have employed insecticides are used in agriculture activities to control weeds and insects, and their use has been associated with large increases in agricultural output. The behavior of pesticides in the environment, such as transport and breakdown, must be examined when pesticides are employed to treat plants. Pesticide misuse, control, and conduct in the environment result in contamination of waters, oil, air, and nutrition.

As a result, pesticide pollution and its harmful impact on the ecosystem and other non-target creatures must be controlled. To fully explain pesticide use and regulation in the future, more studies should be carried out on both human and ecological exposures, as well as the health hazards associated with pesticides.

References

1- Eddleston, M., 2020. Poisoning by pesticides. Medicine 48 (3), 214–217. https://doi.org/10.1016/j.mpmed.2019.12.019.

2- Jia, Z.-Q., Zhang, Y.-C., Huang, Q.-T., Jones, A.K., Han, Z.-J., Zhao, C.-Q., 2020. Acute toxicity, bioconcentration, elimination, action mode and detoxification metabolism of broflanilide in zebrafish, Danio rerio. Journal of Hazardous Materials 394,. https://doi.org/10.1016/j.jhazmat.2020.122521 122521.

3- Bertero, A., Chiari, M., Vitale, N., Zanoni, M., Faggionato, E., Biancardi, A., et al., 2020. Types of pesticides involved in domestic and wild animal poisoning in Italy. Science of the Total Environment 707,. https://doi.org/10.1016/j. scitotenv.2019.136129 136129.

4- USDA-NASS, 2020. United States Department of Agriculture, National Agricultural Statistics Service. Chemical Use Team, 1400 Independence Ave, SW, South Building – Room 6055, Washington, D.C. 20250-2052. https://www.nass. usda.gov/Surveys/Guide_to_NASS_Surveys/Chemical_Use/.

5- Aktar MW, Sengupta D, Chowdhury A. Impact of pesticides use in agriculture: their benefits and hazards. Interdiscip Toxicol. 2009 Mar;2(1):1-12. doi: 10.2478/v10102-009-0001-7. PMID: 21217838; PMCID: PMC2984095.

6- Nag SK, Raikwar MK. Persistent organochlorine pesticide residues in animal feed. Environ Monit Assess. 2011 Mar;174(1-4):327-35. doi: 10.1007/s10661-010-1460-1.

7- Mnif W, Hassine AI, Bouaziz A, Bartegi A, Thomas O, Roig B. Effect of endocrine disruptor pesticides: a review. Int J Environ Res Public Health. 2011 Jun;8(6):2265-303.

8- Garcia, F.P.; Ascencio, S.Y.C.; Oyarzun, J.C.G.; Hernandez, A.C.; Alavarado, P.V. Pesticides: Classification, uses and toxicity. Measures of exposure and genotoxic risks. Int. J. Environ. Sci. Toxic. Res. 2012, 1, 279–293.

9- Amaral, A.F.S. Pesticides and Asthma: Challenges for Epidemiology. Front. Public Health 2014, 2, 6.

10- . Mnif, W.; Hassine, A.I.H.; Bouaziz, A.; Bartegi, A.; Thomas, O.; Roig, B. Effect of Endocrine Disruptor Pesticides: A Review. Int. J. Environ. Res. Public Health 2011, 8, 2265–2303.
11- Kim KH, Kabir E, Jahan SA. Exposure to pesticides and the associated human health effects. Sci Total Environ. 2017 Jan 1;575: 525-535.
12- Zhang, C.; Sun, Y.; Hu, R.; Huang, J.; Huang, X.; Li, Y.; Yin, Y.; Chen, Z. A comparison of the effects of agricultural pesticide uses on peripheral nerve conduction in China. Sci. Rep. 2018, 8, 9621.
13 Aktar,W.; Sengupta, D.; Chowdhury, A. Impact of pesticides use in agriculture: Their benefits and hazards. Interdiscip. Toxicol.2009, 2, 1–12.
14- Lawler, S.P. Environmental safety review of methoprene and bacterially-derived pesticides commonly used for sustained mosquito control. Ecotoxicol. Environ. Saf. 2017, 139, 335–343.
15- Miraglia, M.; Marvin, H.; Kleter, G.; Battilani, P.; Brera, C.; Coni, E.; Cubadda, F.; Croci, L.; De Santis, B.; Dekkers, S.; et al. Climate change and food safety: An emerging issue with special focus on Europe. Food Chem. Toxicol. 2009, 47, 1009–1021.
16- Larsen AE, Gaines SD, Deschênes O. Agricultural pesticide use and adverse birth outcomes in the San Joaquin Valley of California. Nat Commun. 2017 Aug 29;8(1):302.
17- Bergmann, G.E., 2019. Impacts of pesticide pollution on soil microbial communities, ecosystem function and human health. Reference Module in Earth Systems and Environmental Sciences 2019, 1–5.
18- Bhandari, G., Atreya,K., Scheepers, P.T.J.,Geissen,V., 2020.Concentration and distribution of pesticide residues in soil: Nondietary human health risk assessment. Chemosphere 253. https://doi.org/10.1016/j.chemosphere.2020.126594 126594.
19- Alewu B, Nosiri C. Pesticides and human health. In: Stoytcheva M, editor. *Pesticides in the Modern World – Effects of Pesticides Exposure*. InTech; (2011). p. 231–50.
20- Van den Berg H. Global status of DDT and its alternatives for use in vector control to prevent disease. *Environ Health Perspect* (2009) 117:1656–63.
21- Pirsaheb M, Limoee M, Namdari F, Khamutian R. Organochlorine pesticides residue in breast milk: a systematic review. *Med J Islam Repub Iran* (2015) 29:228.
22- Rodríguez-Alcalá LM, Sá C, Pimentel LL, Pestana D, Teixeira D, Faria A, et al. Endocrine disruptor DDE associated with a high-fat diet enhances the impairment of liver fatty acid composition in rats. *J Agric Food Chem* (2015) 63:9341–8.
23- Eskenazi B, Marks AR, Bradman A, Fenster L, Johnson C, Barr DB, et al. In utero exposure to dichlorodiphenyltrichloroethane (DDT) and dichlorodiphenyldichloroethylene (DDE) and neurodevelopment among young Mexican American children. *Pediatrics* (2006) 118:233–41.
24- Lemaire G, Terouanne B, Mauvais P, Michel S, Rahman R. Effect of organochlorine pesticides on human androgen receptor activation *in vitro*. *Toxicol Appl Pharmacol* (2004) 196:235–46.
25- Tiemann U. *In vivo* and *in vitro* effects of the organochlorine pesticides DDT, TCPM, methoxychlor, and lindane on the female reproductive tract of mammals: a review. *Reprod Toxicol* (2008) 25:316–26.
26- Karami-Mohajeri S, Abdollahi M. Toxic influence of organophosphate, carbamate, and organochlorine pesticides on cellular metabolism of lipids, proteins, and carbohydrates: a systematic review. *Hum Exp Toxicol* (2011) 30(9):1119–40.

27- Freire C, Koifman RJ, Koifman S. Hematological and hepatic alterations in brazilian population heavily exposed to organochlorine pesticides. *J Toxicol Environ Health A* (2015) 78:534–48.
28- Robinson T, Ali U, Mahmood A, Chaudhry MJ, Li J, Zhang G, et al. Concentrations and patterns of organochlorines (OCs) in various fish species from the Indus River, Pakistan: a human health risk assessment. *Sci Total Environ* (2015) 541:1232–42.
29- Gasnier C, Dumont C, Benachour N, Clair E, Chagnon MC, Séralini GE. Glyphosate-based herbicides are toxic and endocrine disruptors in human cell lines. *Toxicology* (2009) 262:184–91.
30- Jaga K, Dharmani C. Sources of exposure to and public health implications of organophosphate pesticides. *Rev Panam Salud Publica* (2003) 14:171–85.
31- Li D, Huang Q, Lu M, Zhang L, Yang Z, Zong M, et al. The organophosphate insecticide chlorpyrifos confers its genotoxic effects by inducing DNA damage and cell apoptosis. *Chemosphere* (2015) 135:387–93.
32-Hung DZ, Yang HJ, Li YF, Lin CL, Chang SY, Sung FV, et al. The long-term effects of organophosphates poisoning as a risk factor of CVDs: a nationwide population-based cohort study. *PLoS One* (2015) 10:e0137632.
33- Eskenazi B, Harley K, Bradman A, Weltzien E, Jewel NP, Barr DB, et al. Association of *in Utero* organophosphate pesticide exposure and fetal growth and length of gestation in an agricultural population. *Environ Health Perspect* (2004) 112:1116–24.
34- Rauh VA, Garcia WE, Whyatt RM, Horton MK, Barr DB, Louis ED. Prenatal exposure to the organophosphate pesticide chlorpyrifos and childhood tremor. *Neurotoxicology* (2015) 51:80–6.

35- Goad ER, Goad JT, Atieh BH, Gupta RC. Carbofuran-induced endocrine disruption in adult male rats. *Toxicol Mech Methods* (2004) 14:233–9.
36- Li Q, Kobayashi M, Kawada T. Ziram induces apoptosis and necrosis in human immune cells. *Arch Toxicol* (2011) 85:355–61.
37- Li Q, Kobayashi M, Kawada T. Carbamate pesticide-induced apoptosis and necrosis in human natural killer cells. *J Biol Regul Homeost Agents* (2014) 28:23–32.
38- Li Q, Kobayashi M, Kawada T. Carbamate pesticide-induced apoptosis in human T lymphocytes. *Int J Environ Res Public Health* (2015) 12:3633–45.
39- Moisan F, Spinosi J, Delabre L, Gourlet V, Mazurie JL, Bénatru I, Goldberg M, Weisskopf MG, Imbernon E, Tzourio C, Elbaz A. Association of Parkinson's Disease and Its Subtypes with Agricultural Pesticide Exposures in Men: A Case-Control Study in France. Environ Health Perspect. 2015 Nov;123(11):1123-9.
40-Pouchieu C, Piel C, Carles C, Gruber A, Helmer C, Tual S, Marcotullio E, Lebailly P, Baldi I. Pesticide use in agriculture and Parkinson's disease in the AGRICAN cohort study. Int J Epidemiol. 2018 Feb 1;47(1):299-310.
41- Piel C, Pouchieu C, Migault L, Béziat B, Boulanger M, Bureau M, Carles C, Grüber A, Lecluse Y, Rondeau V, Schwall X, Tual S, Lebailly P, Baldi I; AGRICAN group. Increased risk of central nervous system tumours with carbamate insecticide use in the prospective cohort AGRICAN. Int J Epidemiol. 2019 Apr 1;48(2):512-526.
42- Vicini JL, Reeves WR, Swarthout JT, Karberg KA. Glyphosate in livestock: feed residues and animal health1. J Anim Sci. 2019 Nov 4;97(11):4509-4518.

43- S. A. Sadiq M. T. Jarjees, The histological and histochemical changes in the kidney of rabbit induced by diazinon. S. A. Sadiq M. T. Jarjees. *Iraqi Journal of Veterinaryciences, 2018,* 32; (2):303-308.
44- Zeljezic D, Garaj-Vrhovac, V, Perkovic P. Evaluation of DNA damage induced by atrazine and atrazine-based herbicide in human lymphocytes in vitro using a comet and DNA diffusion assay. Toxicology in vitro 2006; 20: 923-935.
45- Sathiakumar N, MacLennan PA, Mandel J, Delzell E. A review of epidemiologic studies of triazine herbicides and cancer. Critical Review in Toxicology 2011; 41: 1-34.
46- Kookana RS, Boxal AB, Reeves PT, Ashauer R, Chaudhry Q, Cornelis G, Fernandes TF, Gan J, Kah M, Lynch I, Ranville J, Sinclair C, Spurgeon D, Tiede K, Van Den Brink PJ. Nanopesticides: guiding principles for regulatory evaluation of environmental risks. Journal of Agriculture and Food Chemistry 2014; 62: 4227-4240.
47- Bergeson LL. Nanosilver: US EPA's pesticide office considers how best to proceed. Environmental Quallity Management 2010; 19 [3]: 79−85.
48- Sekhon BS. Nanotechnology in agri-food production: an overview. Nanotechnology, Science and Applications 2014; 7: 31-53.
49- Abdollahi M, Ranjbar A, Shadnia S, Nikfar S, Rezaie A. Pesticides and oxidative stress: a review. Medical Science Monitor 2004;10:141-147.
50- Sayeed I, Parvez S, Pandey S, Bin-Hafeez B, Haque R, Raisuddin S. Oxidative stress biomarkers of exposure to deltamethrin in freshwater fish, Channa punctatus Bloch. Ecotoxicological and Environmental Safety 2003; 56: 295-301.
51- Astaykina A, Streletskii R, Maslov M, Krasnov G, Gorbatov V. Effects of Three Pesticides on the Earthworm *Lumbricus terrestris* Gut Microbiota. Front Microbiol. 2022 Mar 29;13:853535.
52- Norman, J.E.; Mahler, B.J.; Nowell, L.H.; Van Metre, P.C.; Sandstrom, M.W.; Corbin, M.A.; Qian, Y.; Pankow, J.F.; Luo, W.; Fitzgerald, N.B.; et al. Daily stream samples reveal highly complex pesticide occurrence and potential toxicity to aquatic life. *Sci. Total Environ.* 2020, *715*, 136795.
53- Stehle, S.; Buba, S.; Schulz, R. Compilation and analysis of global surface water concentrations for individual insecticide compounds. *Sci. Total Environ.* 2018, *639*, 516–525.
54- Budd, R.; Wang, D.; Ensminger, M.; Phillips, B. An evaluation of temporal and spatial trends of pyrethroid concentrations in California surface waters. *Sci. Total Environ.* 2020, *718*, 137402.
55- Werner I, Schneeweiss A, Segner H, Junghans M. Environmental Risk of Pesticides for Fish in Small- and Medium-Sized Streams of Switzerland. Toxics. 2021 Apr 8;9(4):79.
56- Ghayyur S, Khan MF, Tabassum S, Ahmad MS, Sajid M, Badshah K, Khan MA, Saira, Ghayyur S, Khan NA, Ahmad B, Qamer S. A comparative study on the effects of selected pesticides on hemato-biochemistry and tissue histology of freshwater fish *Cirrhinus mrigala* (Hamilton, 1822). Saudi J Biol Sci. 2021 Jan;28(1):603-611.
57- Mahmood, I., Imadi, S.R., Shazadi, K., Gul, A., Hakeem, K.R. (2016). Effects of Pesticides on Environment. In: Hakeem, K., Akhtar, M., Abdullah, S. (eds) Plant, Soil and Microbes. Springer, Cham. https://doi.org/10.1007/978-3-319-27455-3_13.
58- Aktar MW, Sengupta D, Chowdhury A. Impact of pesticides use in agriculture: their benefits and hazards. Interdiscip Toxicol. 2009 Mar;2(1):1-12.
59- Munz N, Leu C, Wittmer I. Pestizidmessungen in Fliessgewässern - schweizweite Auswertung. Aqua & Gas, 2012, 32-41.

60- Erin M, Hertz-Picciotto BI, James JB. Case cohort analysis of agricultural pesticide applications near maternal residence and selected causes of fetal death. Am. J Epidemiol. 2001; 154(8):702-710.
61- Munshi AB, Detlef SB, Schneider R, Zuberi R. Organochlorine concentrations in various fish from different locations at Karachi Coast. Mar. Pollut. Bull. 2004; 49:597-601.
62- Reeves WR, McGuire MK, Stokes M, Vicini JL. Assessing the Safety of Pesticides in Food: How Current Regulations Protect Human Health. Adv Nutr. 2019 Jan 1;10(1):80-88. doi: 10.1093/advances/nmy061. PMID: 30668620; PMCID: PMC6370255.
63- Khan ZM, Law FCP. Adverse effects of pesticides and related chemicals on enzyme and hormone systems of fish, amphibians and reptiles: A review. *Proc Pakistan Acad Sci.* 2005;42:315–323.
64- Bolognesi C, Merlo FD. Pesticides: human health effects. In: Nriagu JO, editor. *Encyclopedia of environmental health.* Burlington: Elsevier; 2011. pp. 438–453.
65- Mostafalou S, Abdollahi M. Pesticides and human chronic diseases: Evidences, mechanisms, and perspectives. *Toxicol Appl Pharmacol.* 2013;268:157–177.
66- Lawler S.P. Environmental safety review of methoprene and bacterially-derived pesticides commonly used for sustained mosquito control. *Ecotoxicol. Environ. Saf.* 2017;**139**:335–343.
67- Lamichhane J.R. Pesticide use and risk reduction in European farming systems with IPM: An introduction to the special issue. *Crop. Prot.* 2017;**97**:1–6.
68- Tudi M, Daniel Ruan H, Wang L, Lyu J, Sadler R, Connell D, Chu C, Phung DT. Agriculture Development, Pesticide Application and Its Impact on the Environment. Int J Environ Res Public Health. 2021 Jan 27;18(3):1112.