ORGANOCHLORINE PESTICIDE RESIDUE CONTAMINATION OF AGRICULTURAL PRODUCTS IN UGANDA

BY

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A RESEARCH REVIEW SUBMITTED TO THE FACULTY OF SCIENCE AND EDUCATION, DEPARTMENT OF CHEMISTRY IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE EDUCATION OF BUSITEMA UNIVERSITY

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Declaration

I, Chemutai Charity, declare that this research review is my own original work otherwise cited, and where such has been the case reference has been stated and that the same work has not been submitted for any award in any other university or other tertiary institute of higher education.

Signature…… Date…15th/05/2022……

Approval

This research review has been submitted for examination and has been approved by my supervisor.

Dr. Andima Moses

Signature……. Date…15.05.2022……

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Dedication

This report is dedicated to my parents Mr. Moses Kitikoy and Mrs. Janet Kitikoy Yapkwobei who have always supported me spiritual, physically and financially in the entire walk in pursuing my dream. Special thanks also to my siblings, Chebet Herina, Chemutai Levi, Chelangat Brian, Chebet Emmanuel, Chelimo Daniel, Kwemboi Shedrack and Mercy Chepkwemboi who have always supported me in their prayers. Not forgetting my Aunts Esther Cherop and Harriet Yariwo and uncles Lawrence Mutai and Andrew Bushendish who have always advised and guided me in my academic journey.

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List of Acronyms

BHC: benzene hexachloride

DDD: 1,1-ichloro-2,2bis(p-chlorophenyl)ethane

DDT: Dichlorodiphenyltrichloroethane

FAO: food and agricultural organization

HCH: Hexachlorohexane

LOD: lower limit of detection

MRLs: maximum residue levels

OCP: organochlorine pesticides

WHO: world health organization

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Abstract

Organochlorine pesticides have been on use widely having severe usage in the chemical industry, they are developed with an intension of targeting at specific pests, however in their action, it's even toxic to even non targeted organisms Due to continuous usage of OCP's, it is stipulated that the residues of OCP's accumulate in the different matrices of the environment in different parts of the country Uganda because of the usage in both the health sector and also in agriculture. Measurements of organochlorine pesticides can be in fat, blood, urine, semen, and even breast milk, obtaining the levels in urine and blood is easier though may give levels of low concentration regardless of moderate or excessive exposure. Organochlorine pesticides show a greater variety of different structures with much different chemical properties. This may be due to high atomic weight of chlorine, and most of these organochlorine pesticides are heavier than water (denser than water).

CHAPTER ONE: INTRODUCTION

1.1 Background

The invention of organochlorine pesticides started since the 20th century worldwide, organochlorine pesticide compounds have been in use in large quantities both in agriculture and for pest control from 1940s but by 1070s, most countries banned their use since it proved so persistent in the environment. In Uganda, some of these chemicals under the OCPs are being used for vector control and crop production inspite of the bans and restrictions issued in 1970 (Ben et al., 2021).

Pesticides belong to a group of chemicals used to control or destroy insects, pests' fungi, bacteria and many others, they basically include fungicides, herbicides, rodenticides, bactericides and many others, and they may be specific or non-specific in their mode of action (Darko & Acquaah, 2015; Ben et al., 2021).

Organochlorine pesticides also known as synthetic compounds are a group of derivatives of chlorinated hydrocarbons applied adversely is agriculture and chemical industry. The classification of organochlorine compounds is based in three groups; benzenehexachloride isomers (e.g., lindane), cyclodienes (aldrin, chlordane, endosulfan, dieldrin, endrin, heptachlor,), and DDT and its analogues (methoxychlor, dicofol, and chlorobenzylate) (Jayaraj et al., 2016).

Organochlorine pesticides gets into the environment during pesticide applications, land fill disposal of contaminated wastes, releases by manufacturing plants. Organochlorine compounds degrade slowly in the environment, and over or inappropriate use of this pesticides by farmers' results into contamination of environmental water, soil, air, and other types of crops and this has a long-term effect on humans. Organochlorine pesticides are characterized by high lipophilicity, bioaccumulation, having a longer half-life and potential of being

transported for long distances, which result into increased chances of air, water and soil degradation even after many years of application (Ntirushize et al., 2019).

Organochlorine pesticides being toxic and carcinogenic, they can possibly cause serious and dangerous health problems to both animals, mankind, and the environment. The toxicity properties of OCPs are brought about by lipophilic nature, and as a result, they form biological compounds and chemically form combinations which are stable (Kumar et al., 2010).

In reference to epidemiological studies, there are indications that some of these compounds may result into cancer in humans (Aaron et al., n.d.) and in addition, influences the levels of thyroid hormones and reported delays in neurodevelopment in the early childhood caused by the effects of prenatal exposure to dichlorodiphenyltrichloroethane (DDTs). Over exposure to some organochlorines may result to abnormalities in the functioning of the liver, skin, and the nervous system in general (Konuk, n.d.).

1.2 Problem Statement

Organochlorine pesticides (OCP) have been used for agricultural and livestock for a couple of years by most developing countries to combat the problem of crop pests and animal ectoparasites. The need and use of the organochlorine pesticides arouse after the need to increase the productivity of agricultural products, the highly spreading malaria, disease and other deadly human diseases (Harris et al., 2001).

The use of these organochlorine pesticides in most developing countries in particular Uganda has left the environment destroyed, (water, air, and soils). Destruction of soils therefore results into distortion of the life of both macro and microorganism, also, the chemicals are transferred in the plants since the plants absorb them from the soils, destruction of the air makes the aerial life risky and similarly, the water destruction definitely affects the aquatic life (Nyaundi et al., 2019).

Most of these compounds are non-degradable or are slowly degraded, for that reason, the residues remain and accumulate in the food chain and is therefore transferred from one organism to another in the ecosystem (Ntirushize et al., 2019). Examples of these organochlorine pesticides may among others include: aldrin, dieldrin, heptachlor, DDT, HCH and many others yet to be discussed.

Despite the ban on the use of these organochlorine pesticides, locals still use because of the effectiveness for example the use of DDT on the mosquitoes. As a result, there is accumulation of residues of organochlorine pesticide compounds in most parts of Uganda (Ntirushize et al., 2019) which is harmful to both nonhuman and human beings. The purpose of this review therefore is to:

- Assess the nature of organochlorine pesticides and their residues in the environment.
- Assess the levels of organochlorine pesticide residues in some selected agricultural products within Uganda.
- To compare the levels of contamination of agricultural products with organochlorine pesticide residues.
- To assess the impacts of excess consumption of organochlorine pesticide residues in human beings.

1.3 Significance of the Review

The significance of this review is therefore to provide information about the permissible levels of organochlorine pesticide residue consumption, also to develop an idea about the alternative sources of improving agricultural productivity in both plant and animal perspective and avoiding the spread of diseases caused by vectors which are destroyed using organochlorine pesticides.

1.4 Scope of the Review

The scope of this review covers all parts of the country (Uganda) involving both soil, water, air and agricultural products, sold in the local markets in Uganda, agricultural products considered include milk, fish, plant products (different food stuff), meat supplied in the markets inclusive.

REFERENCES

Aaron, B., Shelia, H., & Mary, H. W. (n.d.). *Pesticides and cancer*.

Ademoroti, C. (1996). *Environmental Chemistry and Toxicology*, 79–208.

(AL-Bukhaiti, 2017). Principles, Advantages and Applications in Food Analysis. *International Journal of Agriculture Innovations and Research.* 6(1)

ATSDR. (1999). Toxicological profile for pentachlorophenol. *Agency for Toxic Substance and Disease Registry*.

ATSDRs. (1997). Toxicological profiles. *Agency for Toxic Substance and Disease Registry*.

Augustinjn, B., Hornsby, A., & Wauchope, R. (1994). International code of conduct on the distribution and use of pesticide. *Additional Property Reviews of Environmental Contamination and Toxicology*, *137*, 10–25.

Bagumire, A .W. (2008). Food addict contamination. In *Analysis of environmental food products* (Part B, pp. 153–160). Sub-Saharan Africa.

Bano, M., & Batti, D. (2010). Ameliorative effect of combination of vitamin-E, vitamin C. *Indian Journal of Experimental Biology*, *8*, 48–150.

Ben, S., Allan, S., Kwetegyeka, J., Olisah, C., Matthew, A., Mubiru, E., Tebandeke, E., Matovu, H., Odongo, S., John, J., Abayi, M., Chelangat, E., Sillanp, M., & Ssebugere, P. (2021). *Ecotoxicology and Environmental Safety Organochlorine pesticide residues in Uganda ' s honey as a bioindicator of environmental contamination and reproductive health implications to consumers*. *214*. https://doi.org/10.1016/j.ecoenv.2021.112094

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*. https://doi.org/10.1155/2018/3269065

Chandra, R., Sharpanabharathi, N., Prusty, B. A. K., & Azeez, P. A. (2021). Organochlorine pesticide residues in plants and their possible ecotoxicological and agri food impacts. *Scientific Reports*, 1–9. https://doi.org/10.1038/s41598-021-97286-4

Darko, G., & Acquaah, S. (2015). *Levels of organochlorine pesticide residues* (4th ed., Vol. 4). Kumasi. Ghana.

Fruits, W., Organic, I., & More, F. (2013). *Health Risks of Pesticides in Food What Fruits and Vegetables have the most*.

Harris, C. A., Woolridge, M. W., & Hay, A. W. M. (2001). *Factors affecting the transfer of organochlorine pesticide residues to breastmilk*. *43*.

Jacobson, J., & Jacobson, S. (1996). Intellectual impairment in children exposed to polychlorinated biphenyls in utero. *New England Journal of Medicine*, *335*, 783–789.

Jayaraj, R., Megha, P., & Sreedev, P. (2016). *Organochlorine pesticides, their toxic effects on living organisms and their fate in the environment*. *9*, 90–100. https://doi.org/10.1515/intox-2016-0012

Kampire, E., Kiremire, B., Nayanzi, S., & Kishimba, M. (2011). Organochlorine pesticide in fressh and pasteurized cow's milk from Kampala markets. *Chemosphere*, *84*, 923–927.

Kasosi, G., Kiremire, B., & Bugenyi. (2006). Organochlorine residues in fish and water from Lake Victoria, Uganda. *Journal of Environmental Quality*, *35*, 584–589.

Klaassen, C., Amudur, M., & Doull, J. (1996). Casarett and Doull's toxicology. In *The basic science of poisons* (5th ed.). McGraw Hill.

Konuk, M. (n.d.). *Organochlorine pesticide (OCP) residues in cow's, buffalo's, and sheep's milk from Afyonkarahisar region, Turkey*. https://doi.org/10.1007/s10661-010-1849-x

Kumar, V., Yadav, C. S., Singh, S., Goel, S., Ahmed, R. S., Gupta, S., Grover, R. K., & Banerjee, B. D. (2010). CYP 1A1 polymorphism and organochlorine pesticides levels in the etiology of prostate cancer. *Chemosphere*, *81*(4), 464–468. https://doi.org/10.1016/j.chemosphere.2010.07.067

Longnecker, M. P., Rogan, W. J., & Lucier, G. (1997). *The Human Health Effects of DDT (Dichlorodiphenyl- trichloroehane) and PCBS (Polychlorinated Biphenyls) and an overview of organochlorine in public health*.

Nag, S. K., & Raikwar, Æ. M. K. (2008). *Organochlorine Pesticide Residues in Bovine Milk*. *September 2007*, 5–9. https://doi.org/10.1007/s00128-007-9276-6

Ntirushize, B., Wasswa, J., Ntambi, E., & Adaku, C. (2019). *Analysis for Organochlorine Pesticide Residues in Honey from Kabale District, South-Western Uganda*. 476–487. https://doi.org/10.4236/ajac.2019.1010034

Nyaundi, J., Getabu, A., Onchieku, J., Kinaro, Z., Bassa, S., Nyamweya, C., & Hilda, N. (2019). *Occurrence and distribution of Organochlorine Pesticide Residues in Water and Sediments of Earthen Fish Ponds in South Western*. *19*(2), 47–60.

Nyeko, J., & Obwoya, E. (1993). Pesticide use in livestock production. *African Pest and Environment Management Foundation*.

Ogwok, P., Muyonga, J., & Sserunjogi, M. (2009). Pesticide residues and heavy metals in Lake Victoria. *Bull Environment Contamination Toxicology*, *82*, 529–533.

Publication, A. (2017). *The Journal of Veterinary Medical Science*.

Rica, C., Wang, S., Steiniche, T., Romanak, K. A., Johnson, E., Quiro, R., Mutegeki, R., Wasserman, M. D., & Venier, M. (2019). *Atmospheric Occurrence of Legacy Pesticides, Current Use Pesticides, and Flame Retardants in and around Protected Areas in Costa Rica and Uganda*. https://doi.org/10.1021/acs.est.9b00649

Sahoo, D., Roy, A., & Chainy, G. (2008). Protective effects of Vitamin E and curcumin on L-thyrothin-induced rat testicular oxidative stress. *Chemical and Biological Interactions*, *176*, 121–128.

Shimadzu Corporation (2020). Basics & Fundamentals Gas Chromatography. https://www.shimadzu.com/an.

Singh, N., Sharma, A., Dwivedi, P., Patil, R., & Kumar, M. (2007). Citrinin and Endosulfan induced terotegenic effects in whister rats. *Journal of Applied Toxicology*, *27*(2), 143–151.

Singh, Z., Kaur, J., Kaur, R., & Hundal, S. S. (2016). *Toxic Effects of Organochlorine Pesticides: A Review*. *4*, 11–18. https://doi.org/10.11648/j.ajbio.s.2016040301.13

Ssebugere, P., Kiremire, B., Kishimba, M., Wandiga, S., Nayanzi, S., & Wasswa, J. (2009). DDT and its metabolites in fish from lake Edward, Uganda. *Chemosphere*, 212–215.

Subramanaim, K., & Solomon, J. (2006). Organochlorine pesticide BHC and DDE in human blood. *Indian Journal of Biochemistry*, *21*(2), 169–172.

Susan, S., & Sania, P. (1999). Endosulfan- review of its toxicity and its effects on the endocrine system. *World Wild Life Fund*.

Turyahikayo, E. (2013). Assessing the levels of pesticide residue in livestock products and water around Lake Mburo national park. *A dissertation on Pesticide Residues*.

Vijaya, P., Sowmya, P., Arun, F., Baskaran, R., & Poorman, P. (2011). Protective effects of gallic against lindane induced toxicity in experimental rats. *Food and Chemical Toxicology*, *49*, 991–998.