Special Conference Edition, April, 2022
http://dx.doi.org/10.4314/bajopas.v13i1.74S

Bayero Journal of Pure and Applied Sciences, 13(1): 491 - 495
ISSN 2006 – 6996

HUMAN RISK ASSESSMENT FROM ORGANOCHLORINE PESTICIDES IN CABBAGE PLANT CULTIVATED ALONG THE BANKS OF RIVER GETSI, KANO STATE

[1]Ambrose, E.E., [2]Nuhu, A.A., [2]Paul, E.D. and [2]Yashim, Z.Y.
[1]Department of Chemistry, Federal College of Education (Technical) Bichi Kano state
[2]Department of Chemistry, Faculty of life Sciences, Ahmadu Bello University Zaria, Kaduna state
Corresponding author email: upambrose@yahoo.com

ABSTRACT
The study investigated the human risk assessment of twenty (20) organochlorine pollutants in cabbage plant cultivated along the banks of river Getsi, Kano State. The samples were collected, stored, later extracted and cleaned up using florisil method. Analysis was carried out using gas chromatography-mass spectrometry (GC-MS) with electrocapture detector. The result obtained shows that heptachlor, aldrin, heptachlor epoxide, diedrin, endrin,endosulfan 11,endrin aldehyde, endosulfan sulfate and methoxyclor (about 60%) has health quotient above one. While alpha-BHC, beta-BHC, gamma-BHC, delta-BHC,4.4 DDE,4.4DDD,4.4DDT and diedrin were less than one. The investigation indicated that cumulative irrigation with polluted wastewater fumigated with organochlorine pesticides (River Getsi) has negative effects on soil properties, which consequently affects the quality of cabbage making its health risk index and translocation factor greater than one (1). The hazard quotients of about 60% of the OCPs in cabbage are greater than one and so tend to pose serious health risk to consumers. Fumigation with organophosphate chemicals among others poses little health risk.
Keywords: Organochlorine Pollutant, Pesticides, hazard quotient.

INTRODUCTION

Vegetables are plants or parts of a plant used as food, such as cabbage, potato, carrot or beans. Eating vegetables regularly in diet can have many health benefits by reducing many health related diseases and enhancing the digestion of fats and carbohydrates. Unfortunately, harmful substances such as organic pollutants and heavy metals are found in these vegetables, and this may lead to harmful effects (Usman and Ayodele, 2002). Organic pollutants concentrations in soil are associated with biological and geochemical cycles and are influenced by anthropogenic activities such as agricultural practices, industrial activities and waste disposal methods (Uwah *et al.,* 2009). Contamination and subsequent pollution of the environment by organochlorine pollutants (OCPs) have become a global concern due to their distributions and multiple effects on the ecosystem. Due to their cumulative behaviors, non-biodegradability and persistent in soil and water, they have potential and hazardous effects not only on plants but also on human health (Uwah *et al.,* 2009).

Organochlorine pesticides which are the most popular synthetic organic pollutants mostly abbreviated as OCPs are chemicals designed to combat, prevent or control the various pests and vectors on agricultural crops, domestic animal and human beings. They are toxic organic chemical agents that are intentionally released into the environment to alleviate the spread of pests and vector diseases. Among the OCPs examined, include the following; alpha-BHC, beta-BHC,gama-BHC,delta-BHC, aldrin, heptachlor, dieldrin, endrin, mirex and DDT with its metabolites o,p-DDE, p,p-DDE,o,p-DDD,p,p-DDT and p,p-DDT methods (Uwah *et al.,* 2009).

Lifetime exposure to contaminants such as organic chemicals in the environment through ingestion, inhalation and dermal contact can pose risk to human health. Human health risk process or assessment is used to estimate the nature and probability of adverse health effect in humans exposed to contaminants in environmental media, in the immediate or in the nearest future (Wu *et al.,* 2012). The risk assessment evaluates the consequences of human activities and weighs the adverse effect to public health against the contribution to economic development.

Risk assessment procedures are based on source-pathway-receptor models and it involves the examination of site characteristics, environmental behavior and toxicity of the contaminant, its potential route of entry into the receptor (humans), exposure of the receptors to the contaminants and their response to the dose. Generally, risk assessment has been used by risk managers to link scientific information provided by a risk assessor about potentially hazardous substance for decision making. One of the priorities of sustainable development involves assessment and management of risk due to exposure to contaminants such as trace metals and organic chemicals.

Proximate bank and field along River Getsi is a farming hub used throughout the dry season (over seven months from October to May) in Kano State for cultivation of variety of vegetable crops, which include cabbage, garden egg, carrot, lettuce, spinach, onions, tomatoes and water leaves among others. These vegetables are important part of human food and people eat them raw or also eat them fresh when added to other vegetable. The river receives wastewater from industrial, domestic and agricultural activities and literature research revealed paucity of studies on organochlorine pollutants/ residues in soil and vegetables cultivated in this area.

It is in view of the above that this research work was carried out to study organochlorine pollutants residues in cabbage plant cultivated in this area, as well as carry out human risk assessment of the organochlorine pesticides levels in cabbage plant cultivated on bank of River Getsi. Organochlorine pesticides serve at pre-planting, during planting, harvesting and storage and are farmers delight for its broad efficacy, relatively cheap and availability.

MATERIALS AND METHODS

Description of Sampling Site

River Getsi is the receptor of domestic waste, effluent and wastewater flow from Nassarawa areas of Bompai Industrial Estate. The river runs through the city from the southern to northern parts of the Municipality (used for irrigation among others), covering extensive hydrogeological areas.

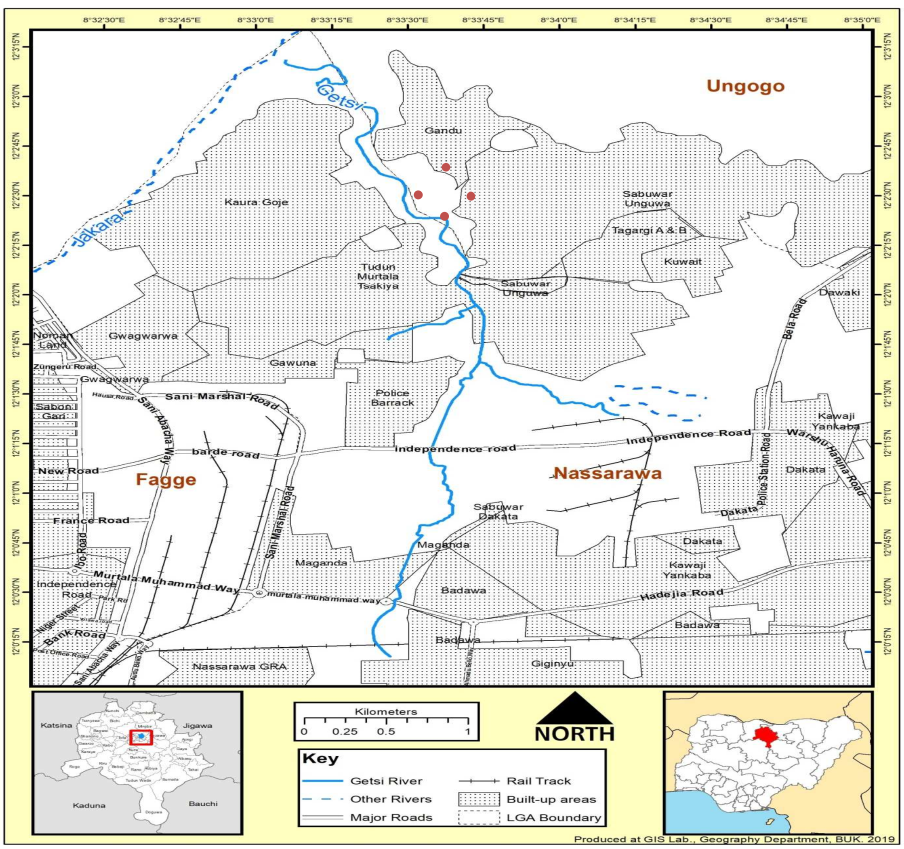

Figure 1: Sampling Points and location along River Getsi

Sample Collection and Preparation

Nine Samples of cabbage plant were randomly collected along the bank of River Getsi during mid-point of dry season. The sampling, collections and preparation of the cabbage samples were conducted according to International Standard Guidelines (Audu and Lawal, 2005). One (1) Kg of nine (9) homogenous composite samples were kept in separate sterile polythene bags, sealed, labeled with unique sample identity, placed in ice chest box (stored at 4 ^{O}C until analysis was performed within 24 hour) and transported to laboratory.

In the laboratory, 50g of cabbage samples (previously washed, dried, chopped and blended into powder) was added to 250 cm^3 beaker containing 100 cm^3 of cyclohexane and dichloromethane (1:1, v/v) with 20 g anhydrous sodium sulphate and later sonicated for 30 minutes at 40 ^{O}C. The solvent extracts were concentrated to 1 cm^3 using a rotary evaporator and kept clean prior to GC-MS analysis (Okop *et al*., 2011).

RESULTS AND DISCUSSIONS

Twenty (20) OCPs were determined in the cabbage food samples analyzed, and the levels of pesticides residues found include mean value, Average Daily Intake (ADI), Estimated Daily Intake (EDI), Health Quotient (HQ) and Health Risk (HR) are presented in Table 1 below.

Hazard indices (HQ) for all residues detected in cabbage are shown in Table 1. Endrin aldehyde has HQs of over 200. The hazard quotients of about 60% of the OCPs in cabbage are greater than one and so tend to pose health risk. The concentration of the DDT isomers did not pose any risk and the concentration determined is far below the recommended maximum limit. This could be attributed to the fact that usage of this organic pollutant has been drastically reduced. In the same vein, the HQs of the four BCHs isomers were less than 1 and therefore indicate no health risk. The three residues (endosulfan 11, endosulfan sulfate and methoxylclor) whose concentrations are above the EU/WHO recommended limits, also have their HQs greater than one. This could pose a serious health risk. This finding is in agreement with similar report by Isaac *et al.,* (2018) whose investigation work was on 'exposure and risk assessment of selected chemical hazards in cabbage and lettuce'. Isaac *et al* (2018) obtained values greater than threshold value for cabbage (3 μg/g) in Romania. In the same vein, the results from the present study correlate with that reported by Tarek *et al.,* (2018) whose analysis centered on human health risks from consuming cabbage grown on wastewater irrigated soil, and they obtained high concentrations in roots and leaves of cabbage plants.

Akan *et al.* (2011) reported the level of organochlorides (dieldrin, DDT, lindane and methoxychlor) and organophosphorous (dichlorvos, diazinon, chlorpyrifos and fenitrothion) pesticide residues in olive oil obtained from Maiduguri. The extraction and cleanup of the olive oil samples were carried out using standard procedures. The levels of all the pesticide residues were determined using Gas Chromatography (GC) equipped with electron capture detector (ECD). The result obtained revealed that, all the pesticide residues in the olive oil samples were below the Maximum Residues Limits (MRLs) of 0.1μg/cm^3 and Acceptable Dietary Intake (ADI) of 0.0001 μg/cm^3; hence the olive oil samples were safe for human consumption.

Table 1: Levels of pesticide residues and Human Risk Assessment of OCPs in Cabbage

OCPs	Mean µg/kg	WHO MRL (mg/L	ADI	BODY SIZE	EDI	HQ	Health Risk
ALPHA – BHC	1.89	10	8.00E-03	Adult	1.76E-03	0.22	NO
	1.89		8.00E-03	Child	2.19E-03	0.27	NO
BETA – BHC	2.3	10	3.00E-03	Adult	2.14E-03	0.71	NO
	2.3		3.00E-03	Child	2.67E-03	0.89	NO
GAMMA - BHC (LINDANE)	0.36	10	3.00E-03	Adult	3.34E-04	0.11	NO
	0.36		3.00E-03	Child	4.18E-04	0.14	NO
HEPTACLOR	0.85	10	1.00E-04	Adult	7.89E-04	7.89	YES
	0.85		1.00E-04	Child	9.86E-04	9.86	YES
DELTA – BHC	0.08	10	3.00E-03	Adult	7.43E-05	0.02	NO
	0.08		3.00E-03	Child	9.28E-05	0.03	NO
ALDRIN	0.03	10	1.00E-04	Adult	2.79E-05	0.28	YES
	0.03		1.00E-04	Child	3.48E-05	0.35	YES
HEPTACHOR EPOXIDE	0.19	10	1.00E-04	Adult	1.76E-04	1.76	YES
	0.19		1.00E-04	Child	2.20E-04	2.20	YES
ENDOSULFAN 1	3.83	10	6.00E-03	Adult	3.56E-03	0.59	NO
	3.83		6.00E-03	Child	4.44E-03	0.74	NO
4, 4-DDE	4.36	-	2.00E-02	Adult	4.05E-03	0.20	NO
	4.36		2.00E-02	Child	5.06E-03	0.25	NO
DIEDRIN	8.03	10	1.00E-04	Adult	7.46E-03	74.56	YES
	8.03		1.00E-04	Child	9.31E-03	93.15	YES
ENDRIN	6.6	10	1.00E-04	Adult	6.13E-03	61.29	YES
	6.6		1.00E-04	Child	7.66E-03	76.56	YES
4, 4-DDD	7.35	-	2.00E-02	Adult	6.83E-03	0.34	NO
	7.35		2.00E-02	Child	8.53E-03	0.43	NO
ENDOSULFAN 11	16.95*	10	6.00E-03	Adult	1.57E-02	2.62	YES
	16.95*		6.00E-03	Child	1.97E-02	3.28	YES
4, 4-DDT	10.16	50	2.00E-02	Adult	9.43E-03	0.47	NO
	10.16		2.00E-02	Child	1.18E-02	0.59	NO
ENDRIN ALDEHYDE	49.61	-	2.00E-04	Adult	4.61E-02	230.33	YES
	49.61		2.00E-04	Child	5.75E-02	287.74	YES
ENDOSULFAN SULFATE	21.96*	10	6.00E-03	Adult	2.04E-02	3.40	YES
	21.96		6.00E-03	Child	2.55E-02	4.25	YES
METHOXYLCLOR	94.51*	10	5.00E-03	Adult	8.78E-02	17.55	YES
	94.51*		5.00E-03	Child	1.10E-01	21.93	YES

*Above the European Union/world health organization minimum residues limit (EU/WHO MRL)

CONCLUSION

Cabbage is one of the most highly consumed vegetables (added in kebab locally known as suya, salad among others), it has high potential to accumulate heavy metals, as well as organochlorine pesticides. The investigation indicated that cumulative irrigation with polluted wastewater with organochlorine pesticide along River Getsi has negative effects on the soil properties, which consequently affects the quality of the cabbage produced, making its health risk index and translocation factor greater than one (1). The study showed that irrigation with polluted wastewater with organochlorine fumigation is not suitable for irrigation of cabbage because of bioaccumulation and biomagnifications of some principal pollutants.

REFERENCES

Akan JC., Abdulrahman FI. Tijani and Chellube Z. (2011): Determination of Pesticides in Extra Virgin and Emir Olive Oil obtained from Maiduguri Metropolis, Borno state. Conference Proceedings of 34th International Conference Workshop and Exhibition of Chemical Society, 'Kwara 2011'. pp 630-635.

Audu, A. A. and Lawal, A.O.,(2005): Variation in metal contents of plants in vegetable gardens site in Kano Metropolis. *Journal of .Applied .Sciences and .Environmental Management.,10(2):105-109*.

Isaac W Ofosu, Samuel Akomea – Frempong,Emmanuel De-Graft Owusu-Ansah and Godfrey Darko (2018):Exposure and risk assessment of selected chemical hazard in cabbage and lettuce. J Toxicol Risk Assess 4:014.Doi org/10.23937/2572-4061.1510014

Okop, I.J., Etukudo, I.U., Okorie, F.S. and Obadimu, C.O.,(2011): Sampling, Extraction and Analytical Evaluation of Volatile Organic Carbon and Few Hydrocarbon in Petroleum Contaminated Soil in Niger Delta, Nigeria. Conference proceedings of 37th international conference workshop of chemical society of Nigeria, tagged Akwa Ibom, 2014. pp 332-336.

Tarek M. Galal, Ahmed A. Khalafallah, Omar E. Elawa & Loutfy M. Hassan (2018): Human health risks from consuming cabbage (Brassica olracea L.var.capitata) grown on wastewater irrigated soil, international journal of phytoremediation,20:10,1007-1016,DOI:10.1080/15226514.2018.1452186.

Usman, S. O. and Ayodele, J. T.,(2002): The Bioaccumulation of Four Heavy Metals in Leaves of *Calotrophis Procera*. *J.Chem.Soc. Nig., 27:26-27.*

Uwah, E., Ndali, N. P. and Ogugbuaja, V. O., (2009): Study of the level of some agricultural pollutants in soils and water leaf (Ta*linum triangulare*) obtained in Maiduguri, Nigeria. *J. Appl. Sci. Environ. Sanita 4(2):71-78.*

Wu, JH, Li, PY, & Qian, H. (2012): Study on the hydrogeochemistry and non-carcinogenic health risk induced by fluoride in Pengyang County, China. *International Journal of Environmental Sciences*. 2(3): 1127-1134. doi:10.6088/ijes.00202030001