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Organochlorine pesticide residues analysis of postharvest cereal grains in Nasarawa State, Nigeria

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Abstract

The study investigated the levels of organochlorine pesticide (OCPs) residues in post harvest grains in Nasarawa State-Nigeria. Millet, guinea corn and maize grains were collected from major markets in the study area, prepared and analyzed for organochlorine pesticides using gas chromatography. The result indicated the presence of varying amounts of ten (10) organochlorine pesticide residues in all the samples. The amounts of total OCPs in the grains were in the order maize (2. 295 mg/kg)>guinea corn (1.885 mg/kg)>millet (1.558 mg/kg). However, only Lindane and Aldrin residues were above the maximum residue limits (MRLs) set by WHO/FAO for cereals hence the need for continuous monitoring and regulation of these pesticides is recommended.

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Introduction

The overgrowing World population has aroused mechanization of agricultural practices to enhance food production to cater for this population which in turn has attracted the increased use of pesticides Worldwide. The Food and Agriculture Organization of the United Nations defines pesticides as any substance or mixture of substances intended for preventing, destroying or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage or marketing of food, agricultural commodities, wood and wood products or animal food stuffs or which may be administered to animals for the control of insects, arachnids or other pests in or on their bodies (FAO, 1986).

Although the role of pesticides in meeting the rising population demand of food have being of great significance, their adverse effects once they become excessively present in the environment cannot be over emphasized. The major routes of entry for pesticides into the human body are the skin, lungs and the gut. The skin of a human adult has a superficial surface area of approximately 1.73 m^2, but it is undoubtedly the major focus of accidental acute exposure. Similarly the respiratory tract provides a very efficient surface for the absorption of substances, whether they are in the form of vapors, particles or droplets (Hashmi and Khan, 2011). Once in the body, they become potential endocrine disruptors due to their lipophilic nature.

The emergent consent among scientists is that small doses of pesticides and other chemicals can cause lasting damage to human health, especially during fatal development and early childhood. There is now much awareness amongst scientists Worldwide about the lethal effects of ingesting these powerful chemicals to advice that we minimize our consumption of pesticides (Fenner-Crisp *et al*, 2010).
Continual application of pesticides to enhance food production has resulted to the remains of their residue on food stuffs. Pesticide residue according to (IUPAC, 1997 & European Communities, 2008) are substances or mixture of substances in food for man or animals resulting from the use of pesticide including any specified derivatives, such as degradation and conversion products, metabolites, reaction products and impurities considered to be of toxicological significance. These substances are highly undesirable in food products when present above the minimum residual limits. Pesticide residue found in food stuffs are of commonly associated with direct application on crops to attack vertebrate pest on farmland (Gwary, *et al* 2012). However of great concern is the postharvest application on storage of grains which in most cases lead to acute toxicity upon consumption without adequate precautionary measures.

Increased pesticide misuse in various sectors of the agriculture often has been associated with health problems and environmental contamination worldwide (Soares *et al.*, 2003; Mancini et al., 2005; Remor *et al.*, 2009). Misuse of highly toxic pesticides, coupled with a weak or a totally absent legislative framework in the use of pesticides, is one of the major reasons for the high incidence of pesticide poisoning in developing countries (Konradsen *et al.*, 2003). Low education levels of the rural population, lack of information and training on pesticide safety, poor spraying technology, and inadequate personal protection during pesticide use have been reported to play a major role in the intoxication scenario (Hurtig *et al.*, 2003; Atreya, 2008). Several cases of food poisoning resulting from pesticide residue have been reported in Nigeria. Gwary *et al* (2012) have reported that high levels of pesticides residues arising from improper application and multiple sprays of sub lethal doses have been reported to be responsible for the poisoning and deaths of people in both rural and urban areas of Borno State and Nigeria in general. The National Agency for Food and Drugs Administration and Control (NAFDAC) revealed the presence food poisons from beans in Taraba State and Doma in Gombe state Northeastern Nigeria. Analysis of these samples was said to contain outrageously high organophosphates, carbamates, fenithrothion and chloropyrifos which are highly toxic pesticides and lindane, an organo chlorinated pesticide that was banned under the 1989 Rotterdam convention (Awofadeji, 2008).

The alarming interest in agriculture has attracted the much use of pesticides which have continued to infiltrate the Nigerian market. Nasarawa State is one amongst the many Northern States in Nigeria whose economy is largely dependent on agricultural produce. However, the rural dwellers that are the anchors of these produce are highly ignorant of the risk associated with the use of these chemicals which can cause acute toxicity or may bioaccumulate in living tissues leading to different ailments. Aside this there exists little or no information about the amount of pesticide residues present in these grains after postharvest storage with chemicals hence the need for monitoring is very eminent. The study focused on the evaluation of organo chlorine pesticide residues present in post –harvest cereals (millet, guinea corn and maize) sold in major markets in Nasarawa state, Nigeria.

Materials and methods

Samples Collection and Preparation

Millet, guinea corn and maize grains were collected in polyethylene bags from three major markets where they are majorly cultivated in Nasarawa State. Each of the cereal obtained from the markets was composited and reduced to laboratory size sample. The samples were homogenized using mortar and pestle. Each sample was weighed (10 g) into an Erlenmayer flask, followed by addition of 50 ml Dichloromethane solvent. The mixtures were then shaken for 2 hrs before sonication for 20 min. each sample extract was filtered into an Eelenmayer flask containing sodium sulphate ($NaSO_4$) for drying of the water molecules and then left for an hour. Furthermore, 5 ml of the extract was cleaned-up using activated silica conditioned with dichloromethane and further concentrated by passing through a stream of Nitrogen gas and the extract was solvent exchanged with acetonitrile to an exact volume of 1 ml and analysed for organochlorine pesticides. At least three replicates were done for each sample. All the samples were then subjected to analysis using gas chromatography-electron capture (GC-ECD) system.

GC Analysis

The HP 5890 GC equipped with electron capture detector was used for the chromatographic separation and was achieved by using diphenyl/dimethyl polysiloxane column. The oven temperature was programmed thus; 100^{o}C/min to 280^{o}C, 8 ^{o}C/min to 300 ^{o}C with a final hold time of 10 min and a constant flow rate of 1 ml/min. Helium was used as the carrier gas to sweep the sample components through the column and the eluents were detected with an EC detector.

Results and discussion

From the results presented in table 1and fig. 1, different types of organochlorine pesticide (OCPs) residues were detected from the samples of postharvest grains collected from the study area.

Table 1. Organochlorine pesticide residues in cereal grains (mg/Kg).

Pesticides Residue	*Millet*	*Guinea corn*	*Maize*
Aldrin	0.13±0.02	0.03±0.10	0.03±0.02
Dichloran	0.01±0.01	0.01±0.04	0.01±0.03
Dieldrin	0.02±0.03	0.02±0.01	0.018±0.01
Endrin	0.03±0.04	0.03±0.03	0.0003±0.10
Endosulfan	0.02±0.01	0.02±0.02	0.005±0.06
Heptachlor Epoxide	0.02±0.02	0.02±0.05	0.02±0.04
Lindane	1.25.00±0.04	0.25.00±0.11	1.00±0.01
Methoxychlor	0.03±0.01	0.96±0.01	1.17±0.03
Mirex	0.02±0.03	0.01±0.03	0.008±0.02
DDT	0.04±0.02	0.04±0.01	0.04±0.01
∑(OCPs < 300 $gmol^{-1}$)	1.263	0.763	1.013
∑(OCPs ≥ 300 $gmol^{-1}$)	0.255	1.190	1.270
∑(OCPs > 400 $gmol^{-1}$)	0.040	0.038	0.013
∑(OCPs) $gmol^{-1}$	1.558	1.885	2.295

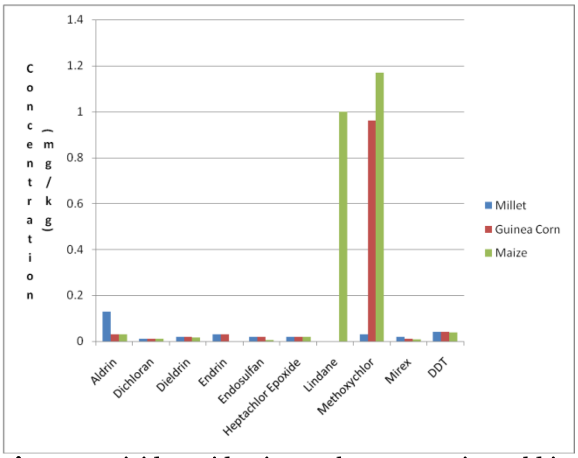

Fig. 1. Pesticide residue in postharvest grains sold in Nasarawa state.

Most common pesticides applied to food crops on field and during storage are organochlorines (Ogah et al, 2011). Those detected in the present study were in the following range; Aldrin (0.03 to 0.13 mg/kg), Dichloran (0.01 mg/kg), Dieldrin (0.018 to 0.02 mk/kg), Endrin (0.0003 to 0.03 mk/kg), Endosulfan (0.005 to 0.02 mg/kg), Heptachlor epoxide (0.02 mg/kg), Lindane (0.25 to 1.25 mg/kg), Methoxychlor (0.03 to 1.17), Mirex (0.008 to 0.02 mg/kg), DDT (0.04 mg/kg) respectively. The amounts of total OCPs in the grains were in the order maize (2. 295 mg/kg)>guinea corn (1.885 mg/kg)>millet (1.558 mg/kg). The low molecular mass OCPs (<300 g/mol) predominated the pesticide residues found present millet while in guinea corn and maize, the pesticide having a molar mass >300 g/mol were predominant. Lindane was the OCP whose level was detected in the highest concentration in all the grain samples (0.25 to 1.25 mg/kg). These levels are above the 0.01mg/kg Maximum residue limit (MRLs) for Lindane stated by FAO/WHO (2013). Also, the levels of Aldrin present in all the grains was found to be above the FAO/WHO recommended MRLs value of 0.02 mg/kg for cereal grains while the Heptachlor and Dieldrin were found in amounts equal to the MRLs of 0.02 mg/kg for cereal grains. These pesticides are persistent organic pollutants that have been banned in most countries of the world but they are however still found occurring in food stuff. Obida et al (2012) also found varying ranges of Organochlorine pesticides in bean samples in Northeastern Nigeria. Endosulfan, DDT and Endrin were also detected in the grain samples but their levels were below their MRLs of 1, 0.1 and 0.05 mg/kg respectively. Osobanjo and Adeyeye (1995) had earlier reported the presence of OCPs residues in cereals in Nigerian markets although their levels were found below the MRLssimilar studies in India and Turkey have also reported the presence of organochlorine pesticides in wheat and other grains I varying amounts (Toteja et al, 2006; Guler et al, 2010). Grains are often stored for a long time at ambient temperatures in bulk silos were insecticides may be applied at postharvest to reduce their attack from storage pest and hence are a major source of these residues in food stuff (Snelson, 1987).

Conclusion

The amount of organochlorine pesticide residue detected in cereal grains from Nasarawa State-Nigeria showed the contamination of the food with the pesticide residues monitored in the present study. Although most of the pesticide residues are below the FAO/WHO MRLs, some exceeded the MRLs recommended. This contamination may pose a danger to human health and hence the need to monitor and control the pesticide residues in grains in these areas is required.

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