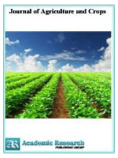

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Effects of Pesticides on Selected Vegetable Crops Grown in Abakaliki, Ebonyi State Nigeria

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Abstract

The study analyzed the effects of pesticides on selected vegetable crops grown in Abakaliki, Ebonyi State Nigeria. The pesticide Dichlorvos (DD Force) was used to treat sites planted with Amaranth, cucumber, and okra. Soil and vegetable samples were randomly collected after 30 days of incorporation and tested for traces of chloride and phosphate. The results of the analysis showed that amaranth, cucumber, and okra residue concentration exceeded the maximum residual limit. Chloride and phosphate residues exceed the Maximum Residue Limit in vegetable crops. The amount of chloride in the soil sample exceeded the Maximum Permissible Limit. The amount of phosphate in the soil samples was lower than the Maximum Permissible Limit. The fact that vegetables are often grown and used with pesticides to control pests requires caution. Therefore, it is recommended that there should be limits and controls on the use and production of pesticides.

Keywords: Agriculture; Vegetablel Fruits; Pesticides; Food production; Dietary; Health.

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1. Introduction

Fruits and vegetables make up the bulk of the diet due to their high nutritional value; not surprisingly healthy nutritionists and other health professionals recommend a daily diet of fruits and vegetables [1]. However, despite the benefits of using these fruits and vegetables, there have been reports of diseases such as cancer, endocrine disorders, immunological effects, neurotoxicity, and many other health problems caused by the continued consumption of contaminated fruits and vegetables [2]. This incident of fruit and vegetable pollution has raised public concerns over its negative effects on human health. Many researchers claim that the contamination of these fruits and vegetables is due to the continued use of pesticides that are banned and approved by farmers during crop production [3].

Feeding the ever-growing population is one of the challenges the world faces today. High declines in food production have led to the use of agricultural fertilizers and pesticides to improve food production [4]. The use of pesticides began with the introduction of arsenic pesticides and organic compounds such as tar, petroleum oil, and dinitrophenol emulsions [5]. Antinnonin (dinitrocresol) is considered to be the first synthetic pesticide when patented. In 1939, after the discovery of pesticides in DDT, a systematic search for organic products was launched [6].

Agriculturally, pesticides are used widely to increase yields, quality improvement, and extend the shelf life of food crops. So pesticides protect the food plants in the garden from a variety of pests and diseases [7]. It is estimated that without pesticides, two-thirds of all the plants in the field could be lost, depriving many people of food and increasing malnutrition [8]. However, a lack of informed selection of pesticides has led to repeated and indiscriminate use of pesticides which has put farmers and consumers at risk because of their toxic residues that continue to eat after ingestion [9]. These residues may cause harmful or chronic toxicity in humans after the use of the treated plant [10]. These toxic effects are most noticeable on vegetables and fruits as they are sometimes eaten fresh.

The insurgence of pests, diseases and other plant pathogens has necessitated the use of pesticides. This is to eliminate both pre-harvest and post-harvest losses so as to maintain high yield. The rapid increase in population growth and the need to maintain food security especially in developing countries has increased the use of these pesticides. It has been reported that the use of pesticides has increased massively with an estimated 2.5 million tons (worldwide) used annually [11].

Today, many agricultural pesticides compounds are available, usually phenoxy, pyrethroid, carbamates, or organo-chlorines. Organo-chlorine pesticides in addition to their natural toxicity are resistant to degradation and stay in the environment for a long period of time [12]. Lipophilically, they can be collected in the human body when small amounts are taken from food. Agricultural use of pesticides (especially pesticides of organochlorine origin) has been prohibited or severely stopped in many developed nations because of their adverse human health effects. The Stockholm on persistent organic pollutants (POPs) conference signed in May 2001 aims to ban these toxic chemicals all over the world.

Although it is generally accepted that home remedies, such as baths and boiling, expunge the residues of pesticides from vegetables and fruits, this is not always the case. Bathing and boiling may not completely remove pesticides (especially organochlorines) [13] and this may pose a threat to public health if they exceed the maximum tolerance level. It is therefore necessary to regularly monitor pesticide levels in food products including vegetables and fruits and to protect consumer health due to food exposure [14].

Increased demand for fruits, vegetables, and other eatable crops for micro consumption and exports have encouraged the use of pesticides in their manufacturing with the aim of controlling and managing pests' effects [15]. Pesticides of organo-chloride origin are resistant to processes like biological, chemical, and photographically bio-accumulate in the tissues of living things and food chains that have a detrimental effect on the health of humans and the environment at large. These chemicals of synthetic organic origin, therefore, contribute to many serious and chronic diseases such as cancer and hormonal disorders [16]. As a result of organo-chlorine-related pesticides, there is an international process to pave the way or reduce organochlorine pesticides and compounds related to the environment.

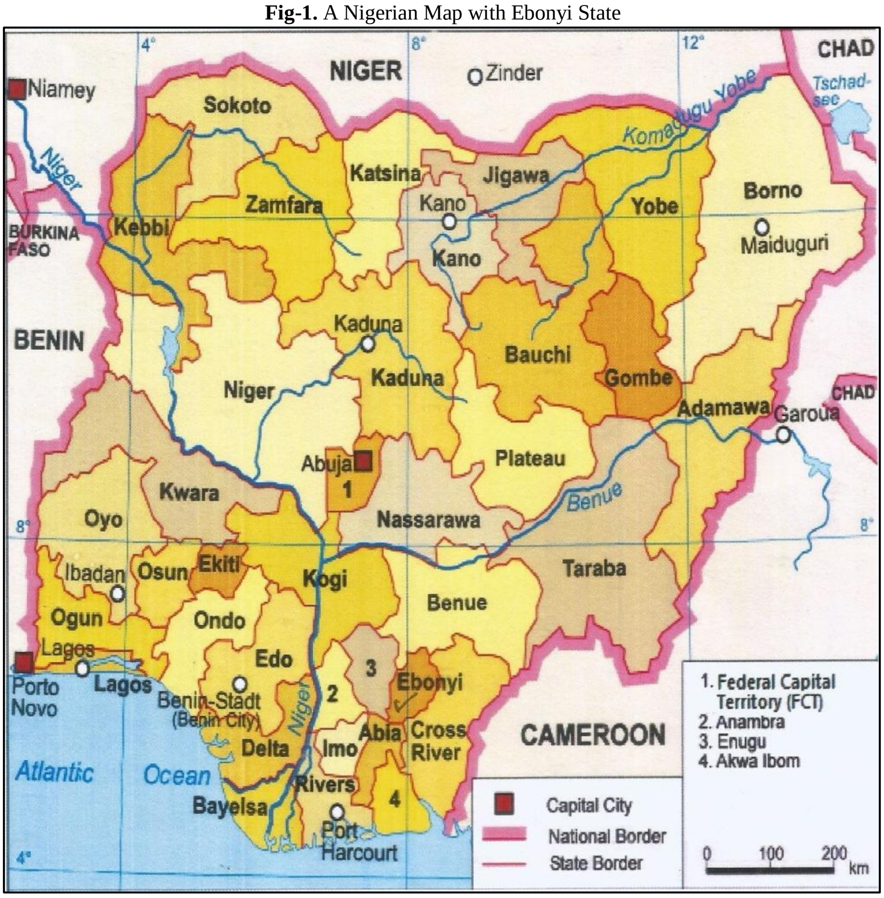
Potential health risk assessments due to exposure to pesticide residues on vegetables and fruits have been done in another world at large [17], therefore the need for this research work.

2. Materials and Methods

2.1. The Study Area

The study was conducted in Abakaliki, Ebonyi State in Fig 1. It lies approximately within Latitude 05^0 4 'and 06^0 4'N at length 07^0 35' and 08^0 25'E. Pseudo-bimodal (April to July and September to November) is the pattern of the rainfall in the study area. It has an annual rainfall of 1700 to 2000 mm and 1800mm as the annual mean. Ebonyi State has 27 ^{0}C as the minimum temperature and 31 ^{0}C as the mean maximum daily temperature. During the rainy season, the humidity of the study area is 80% high, while the dry season is 60% low. The soil classification of the study area is classified under "Ultisol''.

Fig-1. A Nigerian Map with Ebonyi State



2.2. Materials

The DD-force pesticide was used to protect the vegetable crops in the garden. DD-Force is formulated as Dichlorvos (DDVP) 1000g EC (Emulsifiable concentrate). DD-Force contains the following active ingredients: methyl chloride, and phosphate. It belongs to the family of organophosphates as described as a toxic insect in the stomach of a group of pesticides known as ascaricide. Jubaili Agrotec owns the patent for its production and marketing. It is designed for agricultural use only and packed in 100ml, 250ml containers. Eggplant seeds from the garden, amaranth, and cucumber seeds were purchased from the Ebonyi State Agricultural Development program for planting.

2.3. Experimental Design and Layout

The experiments were presented in Randomized Complete Block Design with four treatments and four replicates - namely 0 (control), 0.05, 1, 1.5 liters per ha-1 of DD-force equivalent to 0, 0.2, 0.4, and 0.6 MLS per plot. This is diluted with 360ml of water before applying. The size of the building was 3mx 3m ($9m^2$) and 1m between blocks and 0.5m between sections. Cucumber seeds, seeds of Amaranth and Okra, were planted using a space of 25cm x 25cm to provide 64 plants per plot or 160,000 stands per hectare.

2.4. Soil and Tissue Sampling

To collect the treatments for chloride and phosphate, soil samples were collected for the residue analysis. Soil samples were collected according to the therapeutic analysis of chloride and phosphate residues. Vegetable components (leaves, stems, and roots) were taken and analyzed to detect residues of chloride and phosphate after harvest.

2.4.1. Chloride Determination

Chloride levels were determined with the titrimetric method according to AOAC (1984). This method uses silver nitrate such as titrant and potassium chromate as a point marker and the ion present in the sample is precipitated as silver chloride (white): $Ag^- + Cl^-$- AgCl

The process involves weighing 0.50g of a slurry sample into a washed and dried crucible and then poured into a furnace at 500 ^oC for 3 hours. This is allowed to cool at room temperature and dissolved in 10ml of nitric acid (HNO_3). Approximately 5 ml of ash (aliquot) was a pipette in the conical flask and was mixed with 0.1N silver nitrate ($AgNO_3$) using potassium chromate as an indicator (K_2CrCO_4). The appearance of a reddish-brown rain marking the storage area or the number of titers noted. Chloride concentration (MgL^{-1}) is calculated as follows: $C_c = T_v \times 35.5$

Where C_c is the chloride concentration and Tv is the titer value.

2.4.2. Phosphate Determination

The phosphate status was determined calorimetrically (AOAC, 1984), with 0.5g of the slurry sample measured in a well-washed and dried container. The sample was dissolved in a muffle furnace at 500 ^oC for 3 hours and allowed to cool. It was distilled with 5ml of HNO_3 and made up to 50ml of distilled water. Approximately 5 ml of the diluted sample was pumped through a test tube with 2 ml of ammonium molybdate and 10N sulfuric acid solution. The mixture is mixed and allowed for 10 minutes. The absorbance was read at 420nm using clear water as empty. Typical solutions were taken as a test sample. A phosphate level measurement graph was used to study phosphate concentration: $C_p = A_b \times G_{spg}$

Where C_p is the concentration of the phosphate, Ab is the absorbance and G_{spg} is the gradient from the standard plot of the phosphate concentration.

2.5 Statistical and Data Analysis

Data were analyzed statistically using the coefficient of variance and standard deviation. Values compared with Maximum Residual Limits as defined by Obida, *et al.* [15]; Edeogu [18] and Acceptable Daily Acquisitions.

3. Results

3.1. Chloride Residue in Vegetable Parts after DD-Force Pesticide Application

The results obtained showed that the level of chloride in the root of the vegetables tested after the use of DD force (Dichlorvos) was 16.80 mg kg^{-1} in amaranth, 18.80 mg kg^{-1} in cucumber and 28.35 mg kg^{-1} in okra Table 1. The CV% between treatments was 28.96% with a standard deviation of 6.17 mg kg^{-1}. The result also showed that the amount of chloride in the roots of these vegetables exceeds the maximum residual limit of 0.02-0.2 mg kg^{-1} revealed by Obida, *et al.* [15].

Also in Table 1, the level of chloride in the stem of vegetables analyzed after the use of DD force (Dichlorvos) was 33.0 mg kg^{-1}, 16.80 mg $kg^{-1,}$ and 35.50 mg kg^{-1} in amaranth, cucumber, and okra respectively. However, the standard deviation between treatments was 10.15 mg kg^{-1} with a variance coefficient of 35.70%. The result shows that the amount of chloride in the stem of amaranth, cucumber, and okra exceeded the maximum limit of 0.02-0.2 mg kg^{-1} identified by Obida, *et al.* [15].

The Table 1 result also revealed that the residue of chloride in the amaranth, cucumber, and okra leaves after the use of DD force (Dichlorvos) was 58.10 mg kg^{-1}, 31.40 mg $kg^{-1,}$ and 39.20 mg kg^{-1} respectively. The CV% between treatments was 32% with a standard deviation of 11.21 mg kg^{-1}. The result showed that the estimated amount of this vegetable exceeded the maximum residual limit of 0.02-0.2 mg kg^{-1} as identified by Obida, *et al.* [15].

Table-1. Chloride and Phosphate residue in vegetable parts after DD-Force Pesticide Application

	Plant tissue		
Vegetable	Root	Stem	Leave
Amaranth	16.80	33.00	58.10
Cucumber	18.80	16.80	31.40
Okro	28.35	35.50	39.20
Mean	21.32	28.43	42.90
SD	6.17	10.15	13.73
CV%	0.29	35.70	32.00
Maximum Limit Residue [15]	0.02-0.2	0.02-0.2	0.02-0.2

3.2. Chloride and Phosphate Residue in the Soil

Residues of chloride and phosphate from DD Force (Dichlorvos) pesticides as contained in soil samples are given in Table 2. The result showed that the chlorine residue in the soil after the application of DD force (Dichlorvos) was 52.47 mg kg^{-1} in place of amaranth, 38.29 mg kg^{-1} in place of cucumber, and 42.54 mg kg^{-1} in place of okra. The variance coefficient in all drugs was 16.38% with a standard deviation of 7.28 mg kg^{-1}. Chloride concentration compared to the high level of residue in the soil set by the WHO as identified by Edeogu [18], was found to be below the normal level of 250 mg kg^{-1}.

Phosphate residues in the soil after the application of pesticides were 8.25 mg kg^{-1}, 5.00 mg $kg^{-1,}$ and 6.10 mg kg^{-1} in amaranth, cucumber, and okra plots respectively. The standard deviation of treatment was 1.65 mg kg^{-1} with a variance coefficient of 25.63%. The result shows that the phosphate level in the soil exceeds the set residual phosphate limit of 0.4 mg kg^{-1} Edeogu [18].

Table-2. Chloride and phosphate residue in the soil after DD-Force Pesticide Application

Vegetables	**Chloride (Cl^-)**	**Phosphate (PO_4^-)**
Amaranth	52.47	8.25
Cucumber	38.29	5.00
Okro	42.54	6.10
Mean	44.43	6.45
SD	7.28	1.35
CV%	0.16	20.93
Maximum Limit Residue Edeogu [18].	250	0.4

3.3. Phosphate Residue in Vegetable Parts after DDForce Pesticide Application

The result presented in Table 3 shows the phosphate residue in the roots of amaranth, cucumber and okra after the use of DD force (Dichlorvos). The phosphate residues in vegetable roots were 4.30 mg kg^{-1} in amaranth, 3.55 mg kg^{-1} in cucumber, and 4.45 mg kg^{-1} in okra. The CV% between treatments was 11.76 with a typical deviation of 0.48 mg kg^{-1}. The result showed that the phosphate residue in vegetable roots exceeded the maximum residual limit of 0.02-0.2 mg kg^{-1} [15].

The result presented in Table 3 shows the phosphate residue in the stem of amaranth, cucumber, and okra after the use of DD force (Dichlorvos). The phosphate residues in the stem were 4.45 mg kg^{-1} in amaranth, 3.80 mg kg^{-1} in cucumber, and 3.80 mg kg^{-1} in okra. The coefficient of variance between treatments was 9.34% with a standard deviation of 0.38 mg kg^{-1}. The result also showed that the residual phosphate decreased beyond the maximum residual limit of 0.02-0.2 mg kg^{-1} as revealed by Obida, *et al.* [15].

Table 3 shows the phosphate residue in the leaves of amaranth, cucumber, and okra after the use of DD force (Dichlorvos). The phosphate residues in the leaves of amaranth, cucumber, and okra were 8.65 mg kg^{-1}, 5.60 mg $kg^{-1,}$ and 4.10 mg kg^{-1} respectively. The variance coefficient was 37.91% with a standard deviation of 2.32 mg kg^{-1}. The result also showed that phosphate residues were above the maximum residual limit of 0.02-0.2 mg kg^{-1} as noted by Obida, *et al.* [15].

Table-3. Phosphate residue in vegetable parts after DDForce Pesticide Application

	Plant tissue		
Vegetable	Root	Stem	Leaves
Amaranth	4.30	4.45	8.65
Cucumber	3.55	3.80	5.60
Okro	4.45	3.80	4.10
Mean	4.10	4.02	6.12
SD	0.48	0.38	2.32
CV%	11.76	9.34	37.91
Maximum Limit Residue (Obida *et al.*, 2012)	0.02-0.2	0.02-0.2	0.02-0.2

4. Discussion

The fact that the phosphate of the soil was above the permissible levels may be due to the application of pesticide (Dichlorvos) to the soil. Also, that chloride that has been successfully tested may be because chloride is a trace mineral in the soil that can only combine with sodium and other cations to produce earth salt. In most cases of normal airy and moist soils, conditions of salinity and sodicity do not occur. In the soil tested, there were no reports of soil salinity or sodicity. Therefore, amounts of chloride may come mainly from the pesticide Dichlorvos containing methylchloride, and phosphate as major active ingredients.

The fact that the amaranth, cucumber, and okra flavored Dichlorvos exceeded the standard limits of chloride and phosphate residues may have been due to the use of anion by underground communities as part of their diet; while the low vegetable intake was still within tolerable limits. The work of Edeogu [18] and Obida, *et al.* [15] examined the different levels of anion in Abakaliki soil and plants and the effects of pesticides on plants respectively as shown in Tables 1, 2, and 3. It has been established worldwide that pesticide residues are undesirable in our diet including vegetables as they can be food poisoning [15, 19].

Pesticides can also be lost through immersion, erosion, or chemical degradation of images [20]. Pesticides also affect microbial populations in the soil although micro-organisms which play a major role in the destruction of pesticides in the soil. High-yielding pesticides can be used in high doses, therefore, the recommended pesticide prices.

5. Conclusion

Based on the findings, it can be concluded that Pesticides such as Dichlorvos (DDForce) had an effect on the amaranth, cucumber, and okra residue concentration by exceeding the maximum residual limit, chloride and phosphate residues exceed the Maximum Residue Limit in vegetable crops. The amount of chloride in the soil sample exceeded the Maximum Permissible Limit. The amount of phosphate in the soil samples was lower than the Maximum Permissible Limit. The fact that vegetables are often grown and used with pesticides to control pests requires caution. However, there should be restrictions and controls on their production and usage. This current study is important for Abakaliki, Ebonyi State because, during the production of dry and rainy vegetables, farmers use pesticides as control measures to checkmate pests and insects. Therefore, it is recommended that there should be limits and controls on the use and production of pesticides, with farmer education on safe pesticide use be intensified to limit the levels of pesticides residues in fruits and vegetables. Farmer education on safe pesticide use should be intensified to limit the levels of pesticides residues in fruits and vegetables.

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