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# Levels of Some Agricultural Pollutants in Vegetables Grown in Mkpanak, Ibeno, Akwa Ibom State, Nigeria

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## Abstract

Levels of some agricultural pollutants: trace metals (As, Fe, Ni, and Pb,) and anions ($NO_3^-$ and $NO_2^-$) were investigated in the leaves of *Ocimium grastissimum* (scent leaf), *Telfairia occidentalis* (fruited pumpkin), *Lasianthera africana* (editan), *Gnetum africanum* (afang) obtained in Mkpanak, Ibeno where oil exploration activities are carried out by oil giant, Exxon Mobil and other service companies. The parameters were determined using standard analytical procedures. Ni ranged from 12.44 to 19.34 mg/kg. As were not detected in some of the vegetable samples analysed. Fe ranged from 1.32 to 4.08 mg/kg. Pb ranged from 6.24 to 7.84 mg/kg. $NO_3^-$ ranged from 1.22 to 9.12 mg/kg. $NO_2^-$ ranged from 0.18 to 3.40 mg/kg. Variations of the trace metals in the vegetable samples were in the order Ni > Pb > Fe > As. The anions levels in the vegetable samples were in the order $NO_3^-$ > $NO_2^-$. The results were higher than those of the control samples obtained from Nkek in Ukanafun where there are no oil exploration activities. However, the levels of the trace metals in the vegetable samples obtained in Mkpanak were lower than the published threshold values considered toxic for mature plant tissues. Equally, the trace metal levels in the vegetable samples analysed were within the safe limits stipulated by WHO/FAO, except Pb and Ni which exceeded their limits. The anion levels were equally within the safe limits as posited by WHO/FAO. Nevertheless, there is possible pollution of the study area due to the oil exploration activities which may have negative effects on the growth, fertility and indeed the qualities of vegetables grown in the area. Consumption of these vegetables may not pose health hazards to human at the time of study. However, health hazards due to the high levels of Ni and Pb in the vegetables are most likely in the nearest future in the area. Pb poisoning symptoms like headache, abdominal pain and irritability have been reported in some oil polluted areas in the Niger Delta.

**Keywords:** Agricultural pollutants, vegetables, consumption, Mkpanak, oil exploration activities

## Introduction

Agricultural pollutants are substances such as trace metals and anions that develop in soils and plants with the intensification of agriculture and large – scale use of fertilizers, pesticides, herbicides and other chemicals by the farmers (Uwah *et al*, 2009"a"). These substances can also be developed in soils and plants as a result of other anthropogenic activities such as oil exploration in a particular area. Metals such as Fe, Pb, Zn, As, Ni, Cu and anions such as nitrate, nitrite, phosphate and sulphate have been described as agricultural pollutants, because they are accumulated in the soil mostly from agricultural activities.

Vegetables are the leafy outgrowth of plants used as food and they include those plants and parts of plants used in making soup or served as integral parts of the main sources of our meals (Ihekoronye and Ngoddy, 1985; Uwah *et al*, 2009"b"). Vegetables act as neutralizing agents for acidic substances formed during digestion (Yusuf, 2009). Vegetables are used as stable part of foods both in cooked and raw forms. It is believed that the required amount of vegetables in our daily diet must be 300 to 350 g per person. Vegetables are considered as protective supplementary food and they constitute an important part of the human diets since they contain carbohydrates, proteins, as well as vitamins, minerals and trace elements. In recent years their consumption is increasing gradually, particularly among the urban community. This is due to increased awareness on the food value of vegetables, as a result of exposure to other cultures and acquiring proper education. However, these vegetables contain both essential and toxic elements over a wide range of concentrations particularly due to human activities. Leafy vegetables in particular occupy a very important place in human diet but, unfortunately, constitute a group of foods which contributes maximally to nitrate and other anions as well as heavy metals consumption (Akan, 2013).

Heavy or trace metals are non-biodegradable and persistent environmental contaminants or pollutants which may be deposited on the surface and then absorbed into the tissues of the vegetables. Other non-point sources of contamination affecting agricultural soils are due to various inputs such as fertilizers, pesticides, sewage sludge, organic manures and composts (Singh, 2001). Oil exploration and industrial activities are other factors. According to Wong *et al* (2003), rapid and unorganized industrialization and urbanization have contributed to the elevated levels of heavy metals and other pollutants in the urban environments in developing countries. Environmental pollutants from industrial activities, automobiles exhaust and heavy-duty electric power generators, and other sources are widely distributed in air, water and soil, and therefore have effects on plants, animals and humans which make up the tropic chain. Vegetables absorb heavy metals and other pollutants from the soil as well as from surface deposit on the parts of the vegetables exposed to polluted air. Metals and other pollutants accumulation in vegetables may pose a direct threat to human health (Mohsen and Mohsen, 2008). According to Marbaniang *et al* (2012), the knowledge of metals concentration in foodstuff can provide important information on the impact of the use of chemical products in crops and on the levels of environmental pollution in farms. This is true for all other pollutants.

## MATERIALS AND METHODS

### Study Area

In Mkpanak, Ibeno, Akwa Ibom State, Nigeria, the presence of oil exploration activities by oil giant, Exxon Mobil and other service companies had negative influence on agricultural activities in the area. Considering the health risk posed by polluted vegetables due to agricultural and other anthropogenic activities, it is vital to study the levels of some agricultural pollutants in vegetables obtained in Mkpanak where oil exploration activities are carried out. This will create necessary awareness and minimize ill-health reports. There is therefore, every need for this study.

Ibeno Local Government Area is located at the South end of Akwa Ibom State, occupying a vast coastal area of over 1,200 $km^2$. Ibeno town lies on the eastern side of the Qua Iboe River about 3 kilometres (1.9 miles) from the river mouth, and is one of the largest fishing settlements on the Nigerian coast. It stretches from Okposo I at the eastern flank, bordering Mbo Local Government Area and Bakassi Peninsula to Atabrikang village on its Western flank. It is bounded in the South by the Atlantic Ocean and shares border with Eket, Esit Eket, Onna and Eastern Obolo local government areas. Ibeno occupies the largest Atlantic coastline of more than 129 km. in Akwa Ibom State. Located in the mangrove swamp forest, the area has rain throughout the year with the peak between May and September. The climatic condition in Ibeno is favorable all year round for fishing and farming. The prime occupation of the people is fishing. However, farming and petty trading enjoy appreciative notice. The presence of oil exploration activities by oil giant Exxon Mobil and other service companies influence agricultural activities in both upstream and downstream. Map of Akwa Ibom State showing Ibeno is shown in Figure 1 and map of Ibeno showing Mkpanak (the study area) is shown in Figure 2.

### Samples and Sampling

Edible parts (leaves) of *Ocimium grastissimum* (scent leaf), *Telfairia occidentalis* (fruited pumpkin), *Lasianthera africana* (editan), *Gnetum africanum* (afang) cultivated in Mkpanak, Ibeno where oil exploration activities are carried out by oil giant, Exxon Mobil and other service companies were collected randomly from different farms and pooled together to obtained representative sample of each vegetable and properly labeled. Samples were equally collected from Nkek in Ukanafun where there are no oil exploration activities, to serve as controls.

### Digestion of Samples for Trace Metals Analyses

Sliced vegetable samples were dried in an oven at 105$^{o}$C for 24 hours until they were brittle and crisp. A portion (1g) of each of the dried, disaggregated and sieved vegetables were placed separately in 50 mL Teflon beakers and then digested with 10 mL of $HNO_3$-$HCLO_4$-HF solution to near dryness at 80 – 90$^{o}$C on a hot plate. The digests were filtered into another set of 50 mL volumetric flasks using Whatman No. 42 filter paper and the volumes made up to the marks with distilled water (Uwah *et al*, 2009"a"; USEPA, 1996; Radojevic and Bashkin, 1999).

## Analysis of Samples for Trace Metals

The trace metals level in the digested samples were determined by AAS using model 939/959 UNICAM Spectrophotometer. Standard solutions of 2.5 and 5.0 ppm were prepared for each metal to be determined. Deionized water was used as blank in standardizing the instrument. Calibration curve was constructed by plotting absorbance versus concentration. By interpolation, the concentrations of the metals in the digested samples were determined.

## Samples Preparation for Nitrite and Nitrate Analyses

Vegetable samples were prepared by chopping each sample into smaller sizes. A known amount (1 g) of each of the chopped sample was transferred into separate 100 mL flasks and soaked each with 50 mL of distilled water. The flask was capped and shaken for 30 minutes and then filtered into another set of 100 mL volumetric flasks and the volumes made up to the marks with distilled water (Radojevic and Bashkin. 1999).

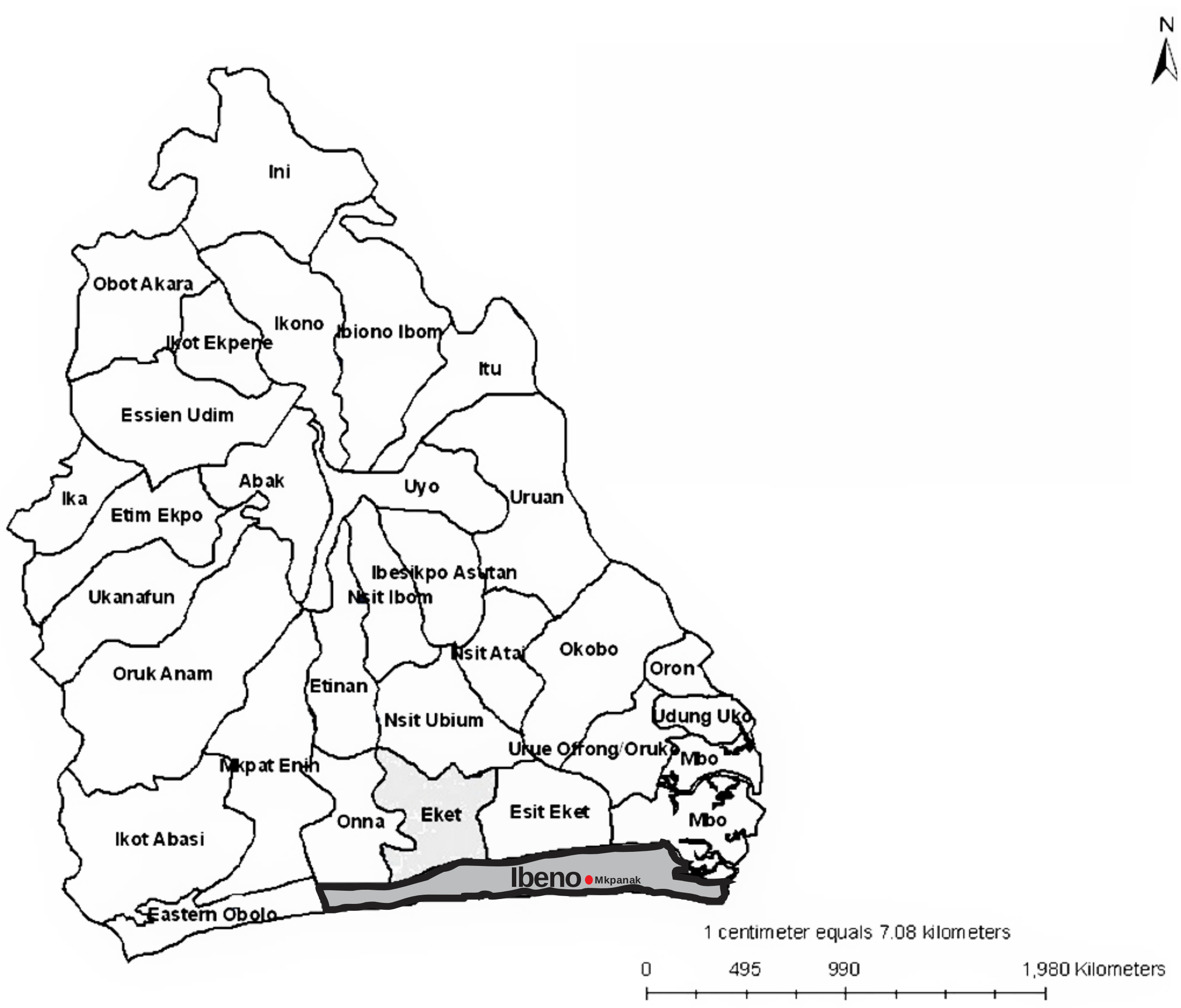


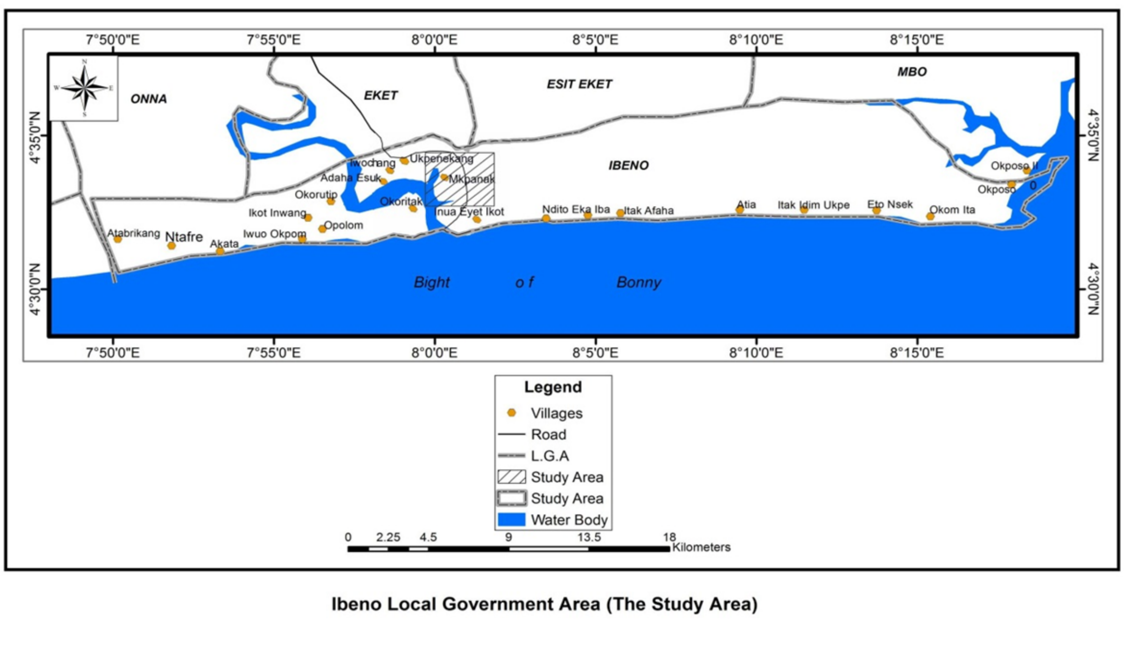

**Figure 1**: Map of Akwa Ibom State showing Ibeno

## Determination of Nitrite

Nitrite levels in prepared sample solutions were determined by the Greiss method. For each vegetable sample, 1.0mL was pipetted into a thoroughly washed test tube and 0.5mL of 0.5% Sodium Carbonate solution was added. Exactly 1.5mL of sulphanilic acid solution (2.7g of potassium hydrogen sulphate and 3.64g of sulphanilic acid dissolved in 1 litre of distilled water) was added. This was followed by the addition of 1.5mL N-(1- naphthaly)-ethylenediamine hydrochloric (NEDA) reagent (0.1g of NEDA in 250mL of distilled water). After mixing, the solution was allowed to stand for 10 minutes. The absorbance of the pink colour developed was read at 550nm in a Spectronic-20 Spectrophotometer (Milton Roy) against sodium nitrate standard solution. Nitrite value was measured from a standard curve for nitrite in concentration range of 0-2.5mg/mL $NO_2$.

### Determination of Nitrate

Nitrate was determined essentially by the colorimetric method. To exactly 25.00mL of each prepared sample solutions, 1mL of Nitrate free $AgSO_4$ (4g/L) was added to remove any interference. Chloride ions precipitate was removed by filtration. Loss of nitrate was prevented by addition of 0.20g of magnesium oxide to 1mL of the filtrate. The optical density of yellow colour developed was measured in an ELL photoelectric colorimeter using blue filter. Deionized water was used as blank and levels of nitrate were extrapolated from the standard curve prepared from 1mL aliquot of potassium nitrate standard solution containing 0.00-20.00µg Nitrate N/mL.




Ibeno Local Government Area (The Study Area)

**Figure 2:** Map of Ibeno showing Mkpanak (the study area)

## RESULTS AND DISCUSSION

### Levels of Some Trace Metals in the Plant Samples

The results for the analyses of some trace metals in vegetable samples are presented in Tables 1 to 4.

**Table 1: Levels (mg/kg) of Some Trace Metals in *Gnetum africanum* obtained in Mkpanak, Ibeno**

| Trace metals | Study Site | Control |
|---|---|---|
| Ni | 19.20 | 0.49 |
| As | 0.001 | BDL |
| Fe | 1.32 | 0.11 |
| Pb | 6.24 | 0.12 |

BDL = Below detection limit

**Table 2: Levels (mg/kg) of Some Trace Metals in *Ocimium grastissimum* obtained in Mkpanak, Ibeno**

| Trace Metals | Study Site | Control |
|---|---|---|
| Ni | 19.34 | 0.03 |
| As | ND | < 0.002 |
| Fe | 2.09 | 0.90 |
| Pb | 7.84 | BDL |

BDL = Below detection limit, ND = Not detected, < = Less than

Levels of the trace metals analysed in *Gnetum africanum* samples in this study are presented in Table 1. Ni was 19.20 mg/kg in samples from the study area and 0.49 mg/kg in controls. As was 0.001 mg/kg in samples from the study area and was below detection limit in the control samples. Fe was found to be 1.32 mg/kg and 0.11 mg/kg in samples from the study area and the controls, respectively. Pb was 6.24 mg/kg in samples from the study area and 0.12 mg/kg in the controls. Table 2 shows the levels of the trace metals in *Ocimium grastissimum*. Ni was 19.34 mg/kg in samples from the study area and 0.03 mg/kg in the controls. As was below the detection limit in samples from the study area but was less than 0.002 mg/kg in the controls. Fe was 2.09 mg/kg in samples from the study area and 0.90 mg/kg in the controls. Pb was 7.84 mg/kg in samples from the study area but was below detection limit in the controls**.**

**Table 3: Levels (mg/kg) of Some Trace Metals in *Lasianthera africana* obtained in Mkpanak, Ibeno**

| Trace Metals | Study Site | Control |
|---|---|---|
| Ni | 12.44 | 0.014 |
| As | BDL | BDL |
| Fe | 3.12 | 0.74 |
| Pb | 6.25 | < 0.02 |

BDL = Below detection limit, < = Less than

**Table 4: Levels (mg/kg) of Some Trace Metals in *Telfairia occidentalis* obtained Mkpanak, Ibeno**

| Trace Metals | Study Site | Control |
|---|---|---|
| Ni | 16.01 | 0.02 |
| As | 0.03 | BDL |
| Fe | 4.08 | 0.67 |
| Pb | 6.75 | 0.04 |

BDL = Below detection limit

The levels of the analysed trace metals in *Lasienthera africana* obtained in this study are presented in Table 3. Ni was 12.44 mg/kg in samples from the study area and 0.014 mg/kg in the controls. Levels of As were below the detection limits in both samples. Fe was 3.12 mg/kg in samples from the study area and 0.74 mg/kg in the controls. Pb was found to be 6.25 mg/kg in samples from the study area but less than 0.02 mg/kg in the controls. Shown in Table 4 are the levels of the analysed trace metals in *Telfairia occidentalis* obtained from this study. Ni was 16.01 mg/kg in samples from the study area and 0.002 mg/kg in the controls. As levels were 0.03 mg/kg in the samples from the study area but below detection limit in the controls. Fe was 4.08 mg/kg in samples from the study area and 0.67 mg/kg in the controls. Pb was found to be 6.75 mg/kg in samples from the study area and 0.04 mg/kg in the controls.

In general, the levels of the trace metals in all the vegetable samples analysed in this study were in the order Ni > Pb > Fe > As. The levels of these metals in the vegetable samples analysed were lower in the control samples than their corresponding levels in samples from the study area. The high levels of these metals in samples from the study area could be attributed to the oil exploration activities in the area against the control area where there are no such activities.

Similar levels for Fe (1.340 to 4.320 mg/kg) and Pb (1.321 to 6.871 mg/kg) were reported by Obi-Iyeke (2014) in a study of trace metal dynamics in some leafy vegetables consumed in Warri, Niger Delta Region of Nigeria. Only the level of Pb (7.84 mg/kg) in *Ocimium grastissimum* obtained in this study was found to be higher. The level of Ni obtained in this study for *Lasianthera africana* was similar to the one obtained by Kananke *et al* (2014). *Ocimium grastissimum*, *Telfairia occidentalis* and *Gnetum africanum* from this study had higher concentrations of Ni. The levels of lead obtained in a similar study for green leafy vegetables by Wamalwa *et al* (2015) were lower than those obtained in this study for all the vegetables analysed. The levels of As and Fe in *Ocimium grastissimum* obtained in this study were similar to the results obtained in a similar study in some Nigerian vegetables by Aiwonegbe and Ikhuoria (2007). However, the levels of Ni and Pb obtained in this study were higher than those obtained by Aiwonegbe and Ikhuoria (2007). The result obtained for Fe in *Talinum triangulare* (water leaf) grown on waste dumpsites in Uyo Metropolis, Akwa Ibom state by Ebong *et al* (2007) exceeded the levels for Fe in the vegetables analysed in this study. Their results for Pb and Ni were lower than the ones obtained in the vegetables analysed in this study. The values obtained for some trace metals in (spinach) *Amaranthus caudatus* (As, 0.90 ± 0.26; Fe, 10.28 ± 0.61 and Pb, 2.40 ± 0.16 $\mu g\ g^{-1}$) and in (lettuce) *Lactuca sativa* (As, 1.10 ± 0.16; Fe, 40.11 ± 0.16 and Pb, 3.10 ± 0.12 $\mu g\ g^{-1}$) grown in Maiduguri, Nigeria as reported by Uwah *et al* (2011) were lower than the values obtained in the vegetables analysed in this study except Fe, whose levels were higher in the two vegetables.

Nevertheless, the levels of the trace metals obtained in the vegetables analysed in this study were lower than the published threshold values considered toxic for matured plant tissue. The published threshold values are: As, 5 to 10 mg $kg^{-1}$; Fe, 10-20.00 mg $kg^{-1}$; Cu, 20 to 100 mg $kg^{-1}$; Pb, 30 to 300 mg $kg^{-1}$ and Zn, 100 to 400 mg $kg^{-1}$ (Uwah *et al*., 2011; Kabata-Pendias and Pendias, 1984). The critical values or values regarded as excessive are: Zn, >50-100 µg/g; Mn, > 1000-4000 µg/g; Fe, >200-500 µg/g; Cu, > 7-20 µg/g; Pb, > 4-30 µg/g and Cd, > 1-3 µg/g; depending on the plants (vegetables) in question (Uwah *et al*., 2011; EC-UN/ECE, 1995). These could suggest why there is no report of Pb poisoning in the study area despite the high levels of Pb in the vegetables analysed in this study. However, the levels of Pb in the vegetables analysed in this study fall within the dose considered toxic for trace metals in vegetables as given by WHO/FAO. The toxic doses of some selected trace metals in vegetables are in the following ranges: 10-200mg/kg dry weight for Fe, 0.5-10mg/kg dry weight for Cr, 3-20mg/kg for Pb and 60-400mg/kg for Zn (Obi-Iyeke, 2014; WHO/FAO, 1995). The toxic levels for man are: Cr 200mg/day, Fe 200mg/day, Pb 1.00mg/day and Zn 150-600 mg/day (Obi-Iyeke, 2014; WHO/FAO, 1995). The recommended levels of Ni in plants by WHO standard are in the range of 0.1 – 5.00 mg/kg (Dan, 2013). The levels of Ni in the vegetable samples analysed in this study are higher than this WHO recommended standard range of 0.1 – 5.00 mg/kg. It could be stated that the levels of Pb and Ni obtained in the vegetables analysed in this study might lead to possible health hazards to the consumers of such vegetables due to Pb and Ni poisoning. This is true because Pb poisoning symptoms like headache, abdominal pain and irritability have been reported in some oil polluted areas in the Niger Delta (Obi-Iyeke, 2014). The high level of some of the trace metals (Pb and Ni) obtained in the vegetables analysed in this study could be attributed to the presence of contaminants containing high levels of Pb and Ni in the study area due to the oil exploration activities in the area which influence activities both in the upstream and downstream. Agricultural activities like growing of various classes of vegetables by the people in Mkpanak, Ibeno usually suffer a great set back as these vegetables witness degradable growth due to the oil exploration activities which have almost extinct the fertility of soil. Mr. Amos, an indigene of the community said "our rainfall is acidic and our immediate atmosphere has been contaminated due to oil exploration activities so that instead of our vegetables to sprout during rainy seasons they rather die, especially water leaf" (Personal Communication, 16th August, 2016).

**Levels of Nitrite and Nitrate in the Plant samples**

The results for the analyses of nitrite and nitrate in vegetable samples are presented in Figures 1 to 4.

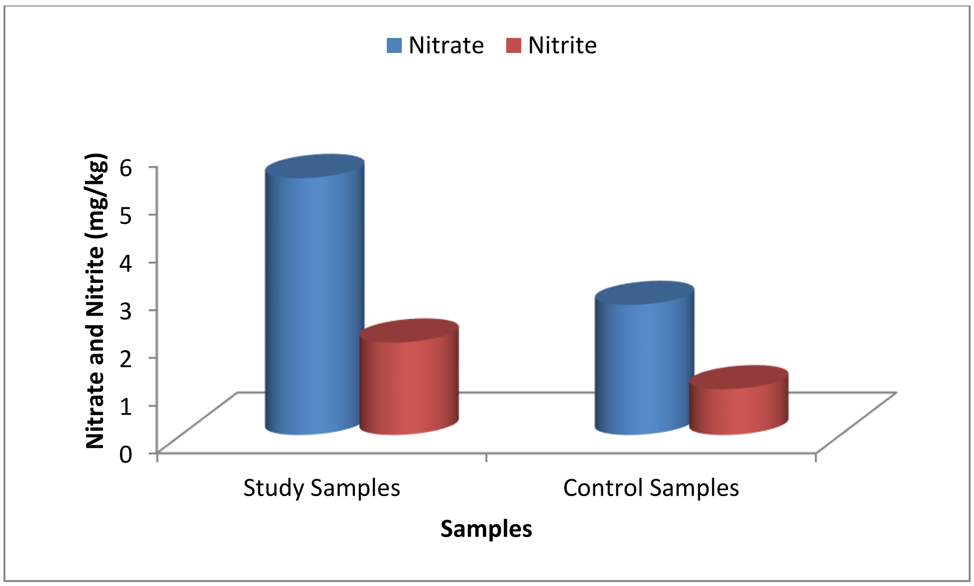



**Figure 1: Levels (mg/kg) of Nitrate and Nitrite in *Gnetum africanum* Samples obtained in Mkpanak, Ibeno**

Levels of nitrate and nitrite analysed in *Gnetum africanum* samples in this study are presented in Figure 1. Nitrate was 5.38 mg/kg in the samples obtained from the study area and 2.73 in the controls. Nitrite was 1.94 mg/kg in the sample obtained from the study area and 0.96 in the controls. Levels of nitrate and nitrite analysed in *Telfairia occidentalis* obtained in this study are presented in Figure 2. Nitrate was 9.12 mg/kg in the samples obtained from the study area and 4.62 mg/kg in the controls. Nitrite was 3.40 mg/kg in the samples obtained from the study area and 1.93 mg/kg in the controls. Levels of nitrate and nitrite analysed in *Ocimium grastissimum* obtained in this study are presented in Figure 3. Nitrate was 1.22 mg/kg in the samples obtained from the study area and 0.99 mg/kg in the control samples. Nitrite recorded 0.18 mg/kg in the samples from the study area and 0.02 mg/kg in the controls.

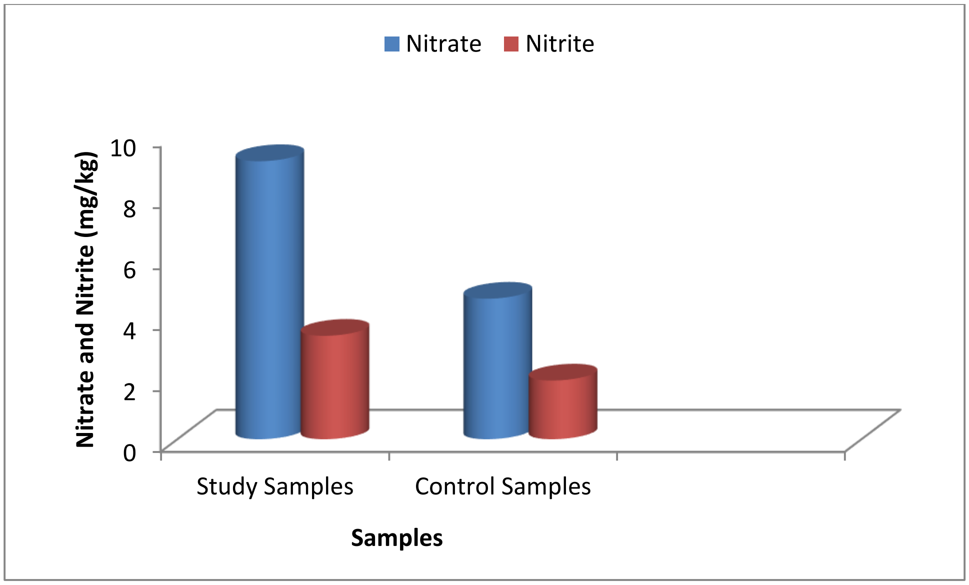



**Figure 2: Levels (mg/kg) of Nitrate and Nitrite in *Telfairia occidentalis* Samples obtained in Mkpanak, Ibeno**

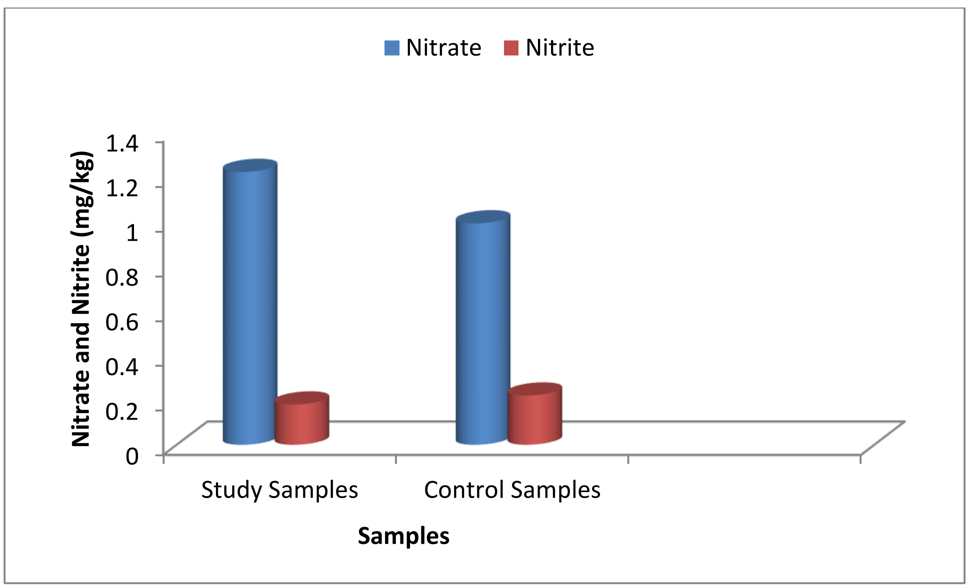



**Figure 3: Levels (mg/kg) of Nitrate and Nitrite in *Ocimium grastissimum* Samples obtained in Mkpanak, Ibeno**

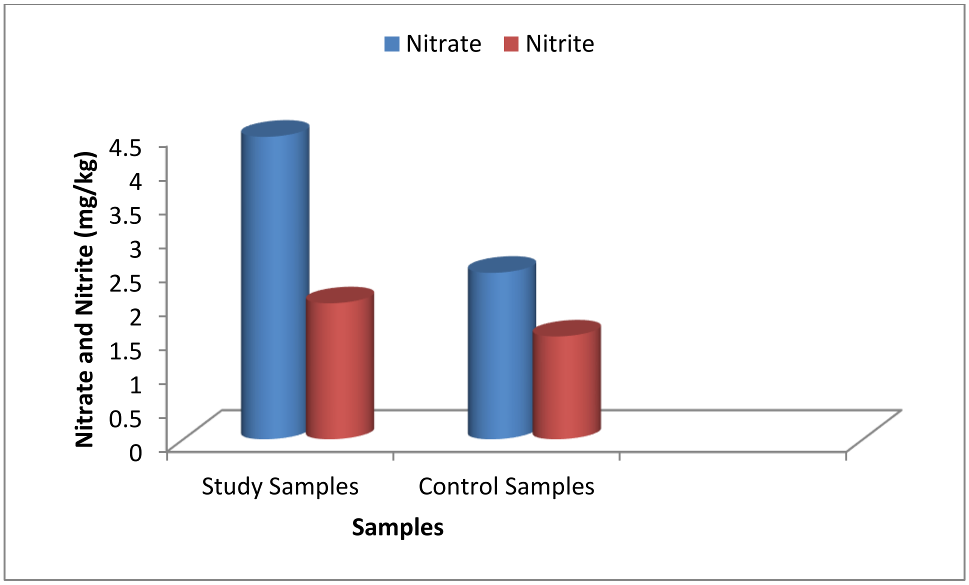



**Figure 4: Levels (mg/kg) of Nitrate and Nitrite in *Lasianthera africana* Samples obtained in Mkpanak, Ibeno**

Levels of nitrate and nitrite analysed in *Lasienthera africana* obtained in this study are presented in Figure 4. Nitrate recorded 4.46 mg/kg in samples from the study area and 2.46 mg/kg in the controls. Nitrite was found to be 2.01 mg/kg in the samples from the study area and 1.52 mg/kg in the controls. The levels of the anions in the vegetable samples analysed were in the order $NO_3^-$ > $NO_2^-$. These values were lower than those reported by Uwah *et al* (2007); Uwah *et al* (2009b) in some fresh vegetables grown in Maiduguri, Borno State with excessive usage of fertilizers, agro-chemicals and irrigation with wastewater.

Similarly, the levels of nitrate and nitrite obtained in this study were lower than those reported by Akan *et al* (2009) in some samples of vegetable grown within the vicinity of Challawa Industrial area, Kano State. The levels of nitrate and nitrite obtained in the vegetable samples analysed in this study were equally lower than those reported by Abah *et al* (2008) in some tuber crops grown in Benue State. In the same vain, the levels of nitrate and nitrite obtained in the vegetable samples analysed in this study were equally lower than those reported by Uwah and Ogugbuaja (2012) in melons (*Curcurbitaceae*) grown in Maiduguri, Borno State with excessive usage of fertilizers, agro-chemicals and irrigation with wastewater. The values reported by Akan *et al* (2013) for nitrate and nitrite in some vegetable samples obtained in Maiduguri, Borno State equally exceeded those reported in this study.

Bockman and Bryson (1989) noted that a joint report by WHO and FAO put the Acceptable Daily Intake (ADI) of nitrate at 3.65 mg $NO_3^-$ $kg^{-1}$ and that of nitrite at 0.2 mg $NO_2^-$ $kg^{-1}$. Another report contained in Walker (1990), indicated that the normal daily intake of nitrate and nitrite varies with dietary custom and that the daily dietary exposure to nitrite is normally very low and usually less than 2 mg $NO_2^-$ $day^{-1}$. Elevated risks for cancer of the urinary bladder, esophagus, pharynx and prostate have been attributed to high nitrate and nitrite ingestion (Eicholzer and Gutzwiller, 1990). Other health problems associated with nitrate and nitrite toxicity include oral cancer (Abah *et al.,* 2008; Badawi *et al.,* 1998), cancer of the colon, rectum and other gastrointestinal regions (Knekt *et al.,* 1999; Turkdogan *et el.,* 2003). Recurrent diarrhea in children up to 8 years of age and recurrent stomatitis are also associated with high nitrate ingestion (Abah *et al.,* 2008; Gupta *et al.,* 1999; Gupta *et al.,* 2001). The levels of nitrate in *Telfairia occidentalis* (fruited pumpkin), *Lasianthera africana* (editan), and *Gnetum africanum* (afang) obtained in this study are higher than the Acceptable Daily Intake (ADI) of nitrate (3.65 mg $NO_3^-$ $kg^{-1}$) as put forward by Bockman and Bryson (1989) while that for *Ocimium grastissimum* (scent leaf) was below. Nitrite levels in afang, fluted pumpkin and editan were similarly higher than the ADI of 0.2 mg $NO_2^-$ $kg^{-1}$ body weight while that for scent leaf was below.

## Conclusions

Based on the analyses and results, we arrived at the following conclusions:

1. The vegetable samples (*Ocimium grastissimum*, *Lasianthera africana, Telfairia occidentalis* and *Gnetum africanum*) obtained in Mkpanak, Ibeno, Akwa Ibom State, Nigeria where oil exploration activities are carried out by oil giant, Exxon Mobil and other service companies, contained variable levels of the analysed trace metals (As, Fe, Pb and Ni) and anions (nitrate and nitrite).
2. The results were higher than those of the control samples obtained from Nkek in Ukanafun where there are no oil exploration activities.
3. However, the levels of the trace metals in the vegetable samples obtained in Mkpanak were lower than the published threshold values considered toxic for mature plant tissues. Equally, the trace metal levels in the vegetable samples analysed were within the safe limits in plants as stipulated by WHO/FAO.
4. The levels of the metals in the vegetables were lower than the established critical limits causing toxicity in plants, except Pb and Ni which exceeded the WHO/FAO safe limits. The anion levels were equally within the safe limits as posited by WHO/FAO.
5. Nevertheless, there is possible pollution of the study area due to the oil exploration activities which may have negative effects on the growth, fertility and indeed the qualities of vegetables grown in the area.
6. Consumption of these vegetables may not pose health hazards to human at the time of the study. However, possible health hazards due to the high levels of Ni and Pb in the vegetables are most likely in the nearest future in the area. Pb poisoning symptoms like headache, abdominal pain and irritability have been reported in some oil polluted areas in the Niger Delta.

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