Impact of Seed Powder of *Dacryodes Edulis* on the Levels of Some Polycyclic Aromatic Hydrocarbons and Heavy Metals in Crude Oil Polluted *Telfairia Occidentalis* Model.

Etim,Okon Effiom[1],Bassey,Utibe Evans[2],Nnamudi,Anthony Chibuzor[3]

[1,3] Department of Biochemistry,PAMO university of medical sciences,Port Harcourt.;
[2] Department of Biochemistry, Obong University, Obong Ntak.

DOI: 10.29322/IJSRP.9.06.2019.p9078
http://dx.doi.org/10.29322/IJSRP.9.06.2019.p9078

Abstract- This study was designed to investigate the phytoremediation effects of *Dacryodes edulis* seeds on the levels of polycyclic aromatic hydrocarbons and heavy metals in germinating leaves of *Telfairia occidentalis* grown in crude oil polluted environment. Differential amounts of the powdered seed of *Dacryodes edulis* was introduced into four cotton wool vessels which were contaminated with crude oil prior to the planting of *T. occidentalis*. The study lasted for eight weeks. The determination of the concentrations of polycyclic aromatic hydrocarbons in *T.occidentalis* leaves and phytochemical composition of the seed of *D. edulis* was carried out using gas chromatographic method. Heavy metals level in leaves of plant model was determined using atomic absorption spectrophotometer. Results obtained from the phytochemical screening showed that the seeds of *Dacryodes edulis* contained varying amounts of alkaloids, saponins, flavonoid, steroid, tannin, phenol, phytosterol, terpenes, cardiac glycoside, anthocyanins, oxalates, phytate and coumarin. Furthermore, introduction of *Dacryodes edulis* seed powder caused a significant reduction in the level of naphthalene and pyrene in the vessel containing 30g *Dacryodes edulis* seed powder. The level of chrysene was significantly reduced in the vessel containing 100g *Dacryodes edulis* seed powder. The levels of acenaphthylene, phenanthrene and anthracene were significantly reduced in all the groups containing *Dacryodes edulis* seed powder relative to the control group. Also, the level of Nickel was significantly reduced in the 100g *Dacryodes edulis* group. These results therefore provide convincing evidence to validate the phytoremediation potentials of *Dacryodes edulis* seed powder.

Index Terms- Dacryodes edulis, gas chromatography, heavy metals, Telfairia occidentalis , polycyclic aromatic hydrocarbons,

I. INTRODUCTION

Crude oil is a complex mixture made of thousands of compounds including alkanes, aromatic hydrocarbons, resins, asphaltenes and heavy metals. The aromatics especially the polycyclic aromatic hydrocarbons (PAHs) are of serious health concern owing to their toxicity to aquatic life and bioaccumulation in living cells. The simplest forms of polycyclic aromatic hydrocarbons are naphthalene, anthracene and phenanthrene (Fetzer, 2000). They are considered hazardous because of their mutagenic and carcinogenic activities (Kalf *et al.,* 1997). Heavy metals have a relatively high density compared to water (Fergusson, 1990). Some of them including arsenic, lead and cadmium induce toxicity at low level of exposure (Duffus, 2002). In recent years, there has been an increasing ecological and global public health concern associated with environmental contamination by these metals (Bradl, 2002). Reported sources of heavy metals in the environment include, geogenic, industrial, agricultural, pharmaceutical, domestic effluents and atmospheric sources. These compounds bioaccumulate in the soil and are transferred to humans through plants cultivated in such contaminated environments.

Oil spillage has been reported in areas with oil exploration activity and it often introduce these chemicals into the environment, particularly contaminating the soil. The presence of these compounds in the soil affect the yield and quality of agricultural products hence negatively impacting agricultural activities. There has been tremendous effort in remediating the environment to bring about its safety after oil spillage. Microorganisms and plants have complementary roles in bioremediation of the polluted soil. Phytoremediation refers to the use of plants to clean contaminated soil (Joner *et al*., 2004). Trees and plants are often planted to take up these chemicals and consumption of such plant product may transfer the accumulated chemicals or heavy metals to man. The African pear tree (*Dacryodes edulis*) is one of such plant that has been studied for its phytoremediation potential.

Dacryodes edulis is an evergreen tree of an African origin (Arisa *et al.,* 2008). The pear fruit is widely consumed for its nutritional potential and has been reported to possess a broad range of medicinal, pharmacological and biological properties that are highly beneficial to human health. It is reported to be anti-microbial, anti-inflammatory, anti-hypertensive, diuretic, and antispasmodics in traditional medicine (Ajayi *et al*., 2002). The seed of plant such as *Moringa oleifera* has been evaluated for its ability to remediate the soil after crude oil contamination and the result is promising (Agboun *et al*., 2016). There is dearth

of information on the utilization of the seed of *Dacryodes edulis* in bioremediation of crude oil contaminated oil, hence the present study designed to evaluate the concentrations of polycyclic aromatic hydrocarbons and heavy metals in germinating leaves of *Telferia occidentalis* grown on crude oil contaminated environment.

Telfairia occidentalis is a tropical vine grown in West Africa as a leafy vegetable and for its edible seeds and leaves. It is a member of the Cucurbitaceae family and is indigenous to southern Nigeria. The leaves are used primarily in soups and herbal medicines. The plant is a drought-tolerant, dioecious perennial that is usually grown through seed (Nwanna *et al*., 2008). Furthermore, the shoots and leaves can be consumed as vegetables. When *T. occidentalis* is prepared for herbal medicine, it is used to treat sudden attack of convulsion, malaria, and anaemia; it also plays a vital and protective role in cardiovascular diseases (Giami, *et at*., 2003). There are several reports on the nutritional and medicinal potential of this very popular and widely cultivated and consumed plant. The popularity of this plant informed its utilization in the present study.

II. MATERIALS AND METHOD

Dacryodes edulis Seed

The fruits of *Dacryodes edulis* were harvested from *Dacryodes edulis* tree in Port Harcourt, River State, Nigeria. They were washed with clean water, cut open and the seeds removed. The seeds were allowed to dry under room temperature. The dried seeds were ground to powder using manual grinder. The powdered seed was used for the study.

Telfairia Occidentalis Seed

The seeds of *Telfairia Occidentalis* were procured from one of the university farmland in Madonna University, Elele, Rivers State. They were dried and made ready for planting.

Crude oil

Bonny light crude oil was obtained from the Nigerian National Petroleum Corporation (NNPC), Port Harcourt, River State, Nigeria.

Experimental Design

Soil sample for planting was prepared into a nursery with sterile cotton wool serving as the soil. The cotton wool was divided into four planting vessels; Vessels 1 – 4. Crude oil was applied on the cotton wool in the vessels to contaminate it. Varying amount of the powdered seed of *Dacryodes edulis* was applied on the crude oil contaminated cotton wool prior to the planting of *Telfairia occidentalis* seed on the crude oil contaminated soil. The experimental design was as stated below:

Vessel 1 - *Telfairia occidentalis* seed + 400 ml of crude oil + water

Vessel 2 - *Telfairia occidentalis* seed + 400 ml of crude oil + 30 g of powdered *Dacryodes edulis* seed + water.

Vessel 3 - *Telfairia occidentalis* seed + 400ml of crude oil + 70 g of powdered *Dacryodes edulis* seeds + water

Vessel 4 - *Telfairia occidentalis* seed + 400ml of crude oil + 100 g of powdered *Dacryodes edulis* seed + water

The seeds of *Telfairia occidentalis* were planted and monitored for eight weeks. The seeds germinated and the leaves of the germinating plant were harvested, air-dried under room temperature, pulverized and processed for determination of the concentrations of polycyclic aromatic hydrocarbon and heavy metals using gas chromatography and atomic absorption spectrophotometer. The phytochemical composition of the seed of *Dacryodes edulis* was also evaluated using gas chromatography.

Preparation of *Telfairia occidentalis* Leaf and Determination of Polycyclic Aromatic Hydrocarbon

The leaf of *Telfairia occidentalis* was extracted for the analysis of polycyclic aromatic hydrocarbon profiles based on the modified methods of ASTM D3328 and ASTM 3415. Hexane and dichloromethane in the ratio of 3 to 1 were used as solvent for the extraction of the plant material. The pulverized leaf was macerated in the solvent for 2 hours. The organic layer of the filtrate was obtained and dried by passing through a funnel containing anhydrous sodium sulphate and then concentrated with a stream of nitrogen gas. Naphthalene, acenaphthylene, phenanthrene, anthracene, pyrene and chrysene were some of the polycyclic aromatic hydrocarbon assayed in the leaf of *Telfairia occidentalis* using gas chromatography.

Preparation of *Telfairia occidentalis* Leaf and Assay of Heavy Metal Composition

The concentrations of heavy metals including nickle, chromium, arsenic and lead in the germinating leaf of *Telfairia occidentalis* were assayed using atomic absorption spectrophotometer.

Phytochemical Screening of *Dacryodes edulis* Seed

The phytochemical composition of the seed of *Dacryodes edulis* was evaluated using gas chromatography.

III. RESULT

Phytochemical composition of *Dacryodes edulis* seed

The phytochemical composition of the seed of *Dacryodes edulis* is presented in Figure 1.0. Phytochemicals including alkaloids, saponins, flavonoids, steroid, tannin, phenol, phytosterol, terpenes, cardiac glycoside, anthocyanins, oxalates, phytate and coumarin were detected in the seed of *Dacryodes edulis*.

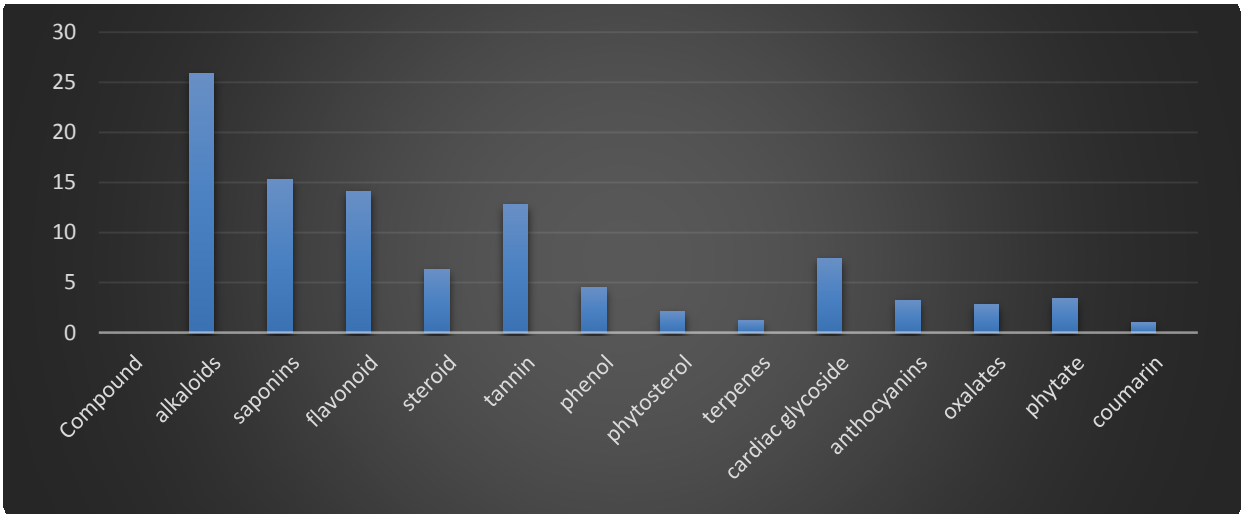
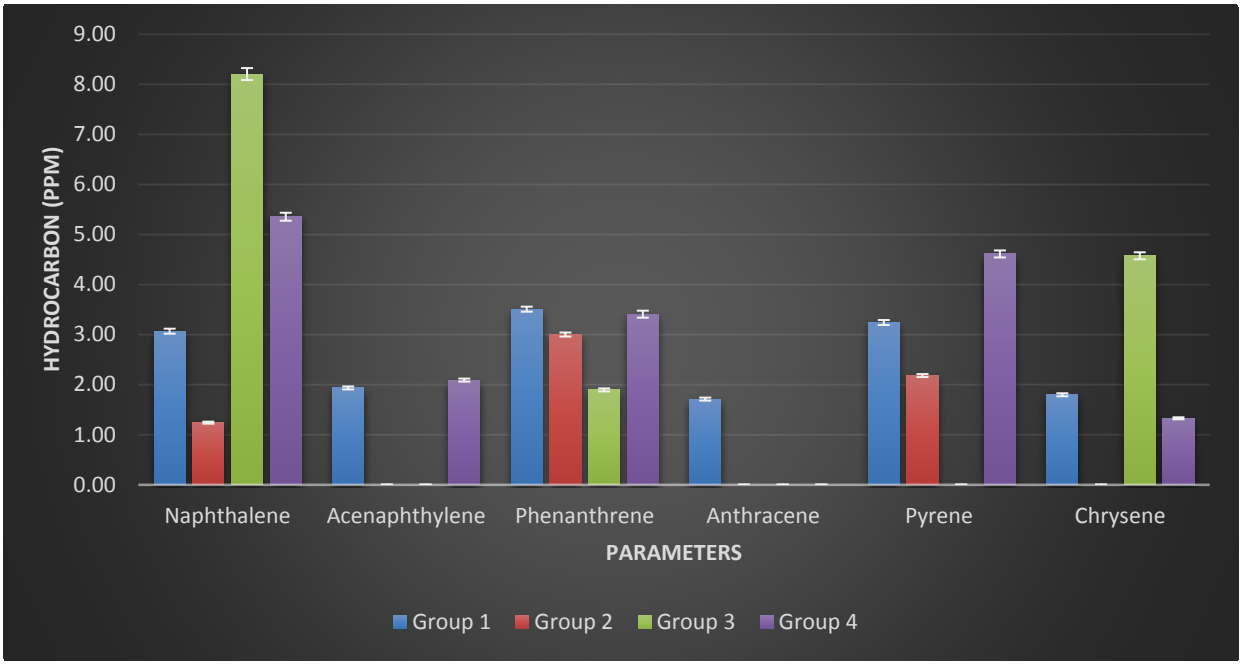


Figure 1.0: Phytochemical composition of seed of *Dacryodes edulis*

Effect of *D. edulis* seed on some polycyclic aromatic hydrocarbon levels in the leaf of *Telfairia occidentalis* grown in crude oil polluted vessel.

The effect of *Dacryodes edulis* seed powder on some polycyclic aromatic hydrocarbon levels in the leaf of *Telfairia occidentalis* grown in crude oil polluted vessels are presented in Figure 2.0. The polycyclic aromatic hydrocarbons under investigation include; naphthalene, acenaphthylene, phenanthrene, anthracene, pyrene and chrysene.

Figure 2.0. Polycyclic aromatic hydrocarbon levels in leaf of *Telfairia occidentalis* grown on crude oil polluted vessel exposed to *D. edulis* seed powder.



Effect of *D. edulis* seed on some heavy metal levels in the leaf of *Telfairia occidentalis* grown in crude oil polluted vessel

Nickle, chromium, arsenic and lead are the heavy metals investigated in the present study. The effect of *Dacryodes edulis* seed powder on the concentrations of these heavy metals in the germinating leaf of *Telfairia occidentalis* is presented in Figure 3.0. Groups 1 – 4 represent vessels 1 – 4 in the experimental design.

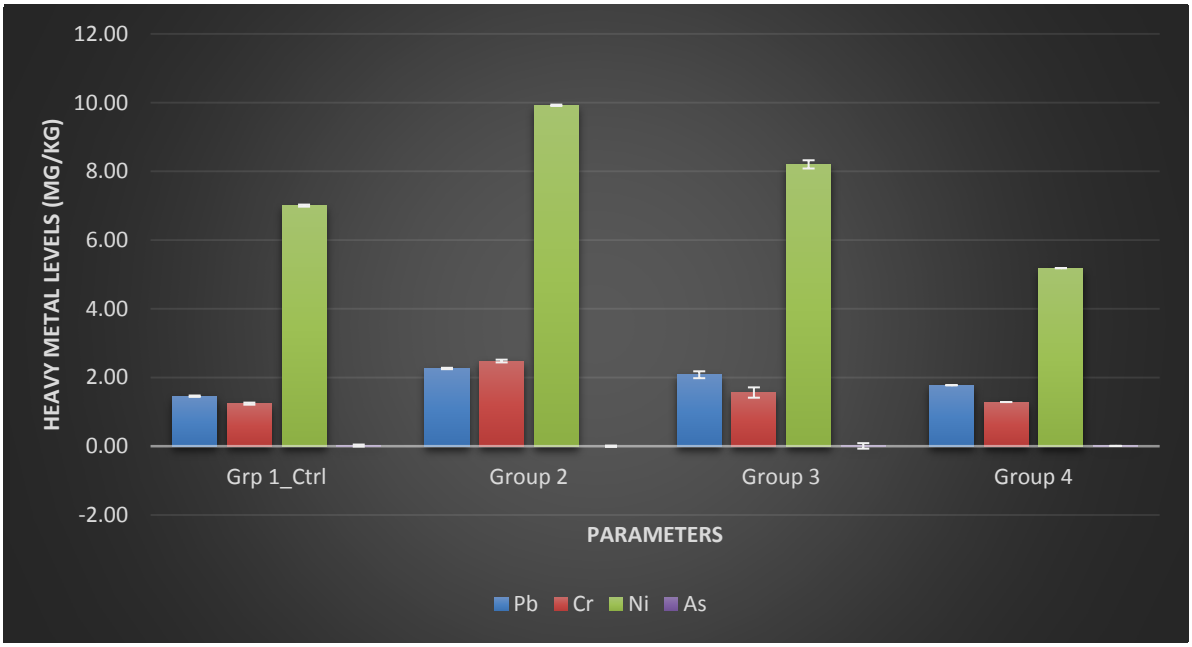


Figure 3.0. Heavy metal concentration in germinating leaf of *Telfairia occidentalis* grown crude oil polluted vessels exposed to *D. edulis* seed powder.

IV. DISCUSSION

Plants are known to absorb nutrients, minerals and other chemical substances from the soil. Substances such as heavy metals and polycyclic aromatic hydrocarbons which may be toxic to other living organisms can be tolerated hence bio-accumulated in plants (Flathmann, 1994). Plants contribute to bioremediation by their ability to fix hydrocarbons and metals due to the presence of some phytochemicals in the plants. This ability can be harnessed to extract hydrocarbons from polluted areas (Chavan, 2008). Phytoremediation can be applied to moderately contaminated soil or after the application of other remediation measures as a polishing step (Frick *et al*., 1999). The present study evaluated the effect of *Dacryodes edulis* seed powder on the concentration of some polycyclic aromatic hydrocarbon and heavy metals in germinating *Telfairia occidentalis* leaf grown in a crude oil contaminated environment. The essence of the study was to evaluate the phytoremediating potential of *Dacryodes edulis* seed powder and its usefulness in preventing bioaccumulation of some polycyclic aromatic hydrocarbon and heavy metals in germinating leaf of *Telfairia occidentalis* grown in crude oil contaminated environment.

The concentrations of polycyclic aromatic hydrocarbons such as naphthalene, acenaphthylene, phenanthrene, anthracene, pyrene and chrysene were evaluated in the germinating leaf of *Telfairia occidentalis* grown in a crude oil contaminated environment. The levels of heavy metals including nickel, lead, arsenic and chromium were assayed using the leaf of germinating *Telfaria occidentalis*. The naphthalene level in the leaf of *Telfairia occidentalis* in the present study as presented in Figure 2.0 was significantly lower ($p<0.05$) in the vessel with 30g *D. edulis* seed powder and significantly higher ($p<0.05$) in the vessel with 70g and 100g *D. edulis* seed powder compared to the control group. The result also showed that there was a significant decrease ($p<0.05$) in the levels of acenaphthylene, phenanthrene and anthracene in plant grown on vessel with 30g, 70g and 100g *D.edulis*.

This result demonstrated a phytoremediative effect of *D. edulis* seed powder by preventing the bio-accumulation of the polycyclic aromatic hydrocarbon in the leaf of *Telfairia occidentalis*. This can be attributed to the phytochemical content of the *Dacryodes edulis* seed particularly the flavonoids. Flavonoids are a class of bioactive components in plant. The concentration of flavonoid in the *Dacryodes edulis* seed in the present study was 14.1%. This metabolite in plant have been reported to be anti-inflammatory and possess antioxidant properties (Robert and Gryglewski, 1988) thereby endowing the plant material with the capacity to chelate the polycyclic aromatic hydrocarbon content in the crude oil polluted soil. Research has been conducted on the principle that free radicals can be blocked and / or scavenged (Adaramony *et al*.,2015), which may serve as a mechanism by which *D.edulis* remediate PAHs.

Pyrene levels were significantly reduced ($p<0.05$) in plants grown on vessels with 30g *D. edulis* and 70g *D. edulis* and were significantly increased in plant leaf grown on vessel with 100g *D. edulis* seed powder compared to the crude oil only vessel. The reason for the decrease in pyrene level in the vessel with 30g *D. edulis* could be due to some of the phytochemical content present in the plant. However, certain factors like nutrients and temperature changes may however be responsible for the significant levels in some of the PAHs. Temperature increase leads to increase in diffusion rate of the organic compounds by decreasing their viscosity which leads to increase in bioavailability by increasing solubility, diffusion and reaction rate (Mohan *et al*., 2006; Northcott and Lones, 2001).

Lead, chromium and nickel levels were higher in plants grown on vessels with 30g 70, and 100g of *D. edulis* compared to the crude oil only vessel though reduced concentration of nickel

was observed in the vessel with 100g of *Dacryodes edulis* seed powder when compared to the control. The concentration of arsenic was lower in the vessels with *Dacryodes edulis* when compared with the control. The results demonstrate that application of higher quantity of *Dacryodes edulis* seed powder significantly reduced the uptake of arsenic from the crude oil contaminated vessel.

The phytochemical composition of *Dacryodes edulis* seed powder consist of alkaloids, tannins, flavonoids, saponins, glycosides, steroids, phytates and oxalates. These phytochemicals, singly or in synergy have been known to be responsible for the various medicinal or toxicological activities of the plant material. Alkaloids, flavonoids, saponins and tannins were observed to be of high concentration in the seed powder of *Dacryodes edulis*. These phytochemicals may be responsible for the phyto-remediating potential of the seed. Conclusively, the seed powder of Dacryodes edulis has the capacity to reduce the uptake of some polycyclic aromatic hydrocarbon and heavy metals by leaf of *Telfaria ocidentalis* planted in crude oil contaminated vessels.

V. CONCLUSION

These work therefore suggest possible implication of *Dacryodes edulis* seed powder in phytoremediation of certain polycyclic aromatic hydrocarbons and heavy metal like nickel though according to the result is concentration dependent.

ACKNOWLEDGEMENT

I sincerely acknowledge the contributions of my partners towards the success of this research work.

REFERENCES

[1] Adaramony, O.A,Farombi,E.O,Adeyemi,E.O.and Emerole,G.O(2005).Comparative study of The antioxidant properties of flavonoids of Garcinia kola seeds. Pakistan *journal of science*. 21,331-339

[2] Ajayi, I. A. and Oderinde, R. A. (2002). Studies on the oil characteristics of *Dacryodes edulis* pulp and seeds. *Discovery and Innovation*, 14: 20-23.

[3] Arisa, N. U. and Lazarus, A. (2008). Production and refining of *Dacryodes edulis* native pear seeds oil. *African Journal of Biotech*, 7(9): 1344-1345.

[4] Duffus, J. H. (2002). Heavy Metals – A Meaningless Term? Pure and applied chemistry, pp, 793 - 807.

[5] Fergusson, J. E. (2006). The heavy metals chemistry: Environmental impact and health effect. 4th ed. Oxford University Press, London, 381-398.

[6] Fetzer, J. C. (2000). The Chemistry and Analysis of the Large Polycyclic Aromatic Hydrocarbons. *Polycyclic Aromatic Compounds*. New York: Wiley; 27(2): 143 - 162.

[7] Flathman, P., Jerger D. E. and Exner, J. H. (1994). Bioremediation Field Experience. Boca Raton, Lewis Publishers.

[8] Giami, and Sunday, Y. (2003). Effect of Germination on Bread-Making Properties of Wheat Fluted Pumpkin (Telfairia occidentalis) Seed Four Blends. Plant Foods for Human Nutrition, 58 (23): 1 - 9.

[9] Kalf, D. F., Commentuijn, T. and Vande Plassche, E. J. (1997). Environmental quality objectives for 10 polycyclic aromatic hydrocarbons (PAHs). *Ecotoxicology and Environmental Safety*, 36(9): 89 - 97.

[10] Nwanna and Emem, E. (2008). Antioxidant and Hepatoprotective Properties of *Telfairia occidentalis* Leaf (Fluted Pumpkin). *Thesis and Dissertation*, 7(9): 9 - 11.

AUTHORS

First Author – Etim,Okon Effiom, Department of Biochemistry,PAMO university of medical sciences,Port Harcourt.; oetim@pums.edu.ng
Second Author – Bassey,Utibe Evans, Department of Biochemistry, Obong University, Obong Ntak.
Third Author – Nnamudi,Anthony Chibuzor, Department of Biochemistry,PAMO university of medical sciences,Port Harcourt, okprince25@yahoo.com; +2348035028377