POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) CONTAMINATION IN PALM OIL SAMPLES FROM MAJOR MARKETS OF OHAFIA AGRICULTURAL ZONE, ABIA STATE, NIGERIA

Sunday O. Eze[1], Kalu Uche Nnenne[1] & Christiana N. Eze[2]
1. Department of Pure and Industrial Chemistry, Abia State University, Uturu, **NIGERIA**
2.Department of Agricultural Economics, Abia State University, Uturu, **NIGERIA**

ABSTRACT

Sequel to the extensive use of palm oil in South Eastern Nigeria and the economic importance of Polycyclic aromatic hydrocarbons (PAHs) contamination in foods, palm oil samples collected from 3 major markets each from the 5 Local Government Areas making up the Ohafia Agricultural Zone of Abia State, in South Eastern Nigeria, were assessed for possible PAHs contamination. Fifteen palm oil samples 3 from each in the major markets in the 5 Local Government Areas of the Agricultural Zone were analyzed using Gas chromatographic techniques with a flame ionization detector (GC – FID). The results show very low concentrations of the PAHs in some of the samples while others were below detectable limits. These include chrysene in sample 6- Nkwoachara Uturu in Isuikwuato Local Government Area with level of (0.02µg/kg), Benz(a) anthracene in sample 9- Eke Isuochi Nkwoagu in Umunneochi Local Government Area, (0.01µg/kg), sample 10- Ibom Arochukwu in Arochukwu Local Government Area (0.1µ/kg) and sample 13 – Abuma Ututu in Arochukwu Local Government Area, (0.2µg/kg), sample 1- Ovim Oriendu in Isukwuato (0.02µg/kg), sample 5- Eluama in Isuikwuato, (0.01µg/kg), sample 7- Uzuakoli in Bende, (0.01µg/kg), sample 8- Akawa Nneato in Umunneochi, (0.1µg/kg). Anthracene was detected in sample 10- Ibom Arochukwu, (0.1µg/kg) and sample 13- Abuma Ututu Arochukwu, (0.2µg/kg). While Fluorene was detected in sample 3- Okoko Item in Bende Local Government Area, (0.01µg/kg). The other polycyclic aromatic hydrocarbon were below detectable limits. Therefore, the levels of these polycyclic aromatic hydrocarbons were far negligible based on EPA and WHO standards so all the palm oil samples are considered safe to human health.

INTRODUCTION

The people of South Eastern Nigeria are known over the years for the production and use of palm oil for edible purposes. It is actually the major and staple cooking oil for the people of Nigeria and particularly the Igbo people of South Eastern Nigeria where Ohafia Agricultural Zone belongs. Palm oil as well as palm kernel as well as palm kernel oil production is a major economic activity among the people especially the rural women The palm kernel oil is mainly used ithe industries for soap production while palm oil is used for cooking.

The origin of the use of palm fruits in tropical Africa cannot easily be traced, but can be dated back as man learnt to extract oil from them. However, at earlier time oil palm can only be traced to the tropical belt of Africa, which includes Nigeria, Zaire, Congo, Liberia, etc. However, the Asian has taken over the large production of oil from Africa. This is because of their possession of more advanced farming methods, e.g. mechanical farming and harvesting (Hartley, 2003). Also many industries depend on oil palm products such as soap, cosmetics, pharmaceutical and polymer industries therefore its importance to the modern world cannot be neglected. The Asian achievement goes a long way to show the relevance or research. Since most of their industries make use of oil palm products, they invested most in research and yield heavy results and Africa are notably a step from them (James, 2000).

Palm oil is an edible vegetable oil derived from the mesocarp (reddish pulp) of the fruit of the oil palm. Palm oil is one of the few highly saturated vegetables fats. It is semi-solid at room temperature and contains several saturated and unsaturated fats in the forms of glyceryl. Palm oil does not contain cholesterol, although saturated fat intake increases a persons LDL and HDL cholesterol (Mensink, *et al.,* 2006).

Palm oil is a common cooking ingredient in the tropical belt of Africa, Southeast Asia and parts of Brazil. Its use in the commercial food industry in other parts of the world is buoyed by its lower cost and the high oxidative stability (saturation) of the refined product when used for frying. Human use of palm oil formed the basis of soap product such as Lever Brothers (now Unilever) “Sunlight” soap and the American Palm Oliver brand (Mathaus, 2007).

Red palm oil gets its name from its characteristic dark red color, which comes from carotenes, such as alpha-carotene, beta-carotenes, and lycopene, the same nutrients that give tomatoes, carrots and other fruits and vegetables their rich colors, red palm oil contains at least 10 other carotenes, along with *Tocopherols* and *Tocotrienol* (members of the vitamin E family) (Bonnie, 2000).

Sterilization of Bunches

Sterilization or cooking means the use of high temperature wet heart treatment to loose fruits. Cooking normally use hot water, while sterilization use pressurized steam. The cooking serves purposes. For scale installation where bunches are cooked whole, the wet heat weakens the fruit steam and make it easy to remove the fruit from bunches on shaking or tumbling in the threshing machines. It also helps to solidify proteins in which the oil bearing cells are microscopically disposed. The protein solidification allows the oil bearing cells to come together and flow more easily on application of pressure (Loh, 2010).

Chemistry of Palm Oil

Palm oil is naturally reddish in colour because of high beta-carotene content. It is not to be confused with palm kernel oil derived from the kernel of the same fruit or coconut palm. The differences are in color, (raw palm kernel oil lacks carotenoids and is not red) and in saturated fat content. Palm mesocarp oil is 41% saturated, while palm kernel oil and coconut oil are 81% and 86% saturated respectively (Cotteril, 2005). Palm oil is one of the few lightly saturated vegetable fats. It is semi-solit at room temperature and contains several saturated and unsaturated fats in the forms of glyceryl Laurate (0.1%) saturated palmitate (44% saturated), Stearate (5% saturated), Oleate (39% nonsaturated), Linoleate (10%, Polysaturated) and alpha-linoleate (0.3% polyunsaturated). Palm oil does not contain cholesterol although saturated fat intake increases a person’s LDL and HDL cholesterol (Mensink *et al*., 2006).

Palm oil is composed of fatty acids, esterifies with glycerol like all fat, unlike all fat, it is high in saturated fatty acid which are solid at room temperature. Palm oil gives its name to 16-carbon saturated fatty acids, palmitic acid. Mono saturated Oleic acid is also a constituent of palm oil. Unrefined palm oil is a large natural source of tocotrienol, part of the vitamin E family fatty acid content of palm oil.

Table 1: Some Fatty Acid Content of Palm Oil

Types of Fatty Acid	Percentage Content
Myristic saturated C_{14}	1.0%
Palmitic saturated C_{16}	43.5%
Stearic saturated C_{18}	4.3%
Oleic mono saturated C_{18}	36.6%
Linoleic poly saturated C_{18}	9.1%

Nutritional Benefit in Palm Oil

Palm oil is rich in phytonutrients red, owes the majority of its antioxidant super powers to its high concentration of carotenes and tocotrienols. Carotene such as lycopene and beta-carotene which lend the bright red and orange hues and powerful health benefits to tomatoes and carrots (Qureshi, 2000). Tocotrienols are a superior form of Vitamin E, 40 to 60 times more powerful than tocopherols that control free radicals and inflammation. Tocotrienols are also powerful anti-cancer agents that help ward off cancers of the skin, stomach, pancreas, liver, lung. Tocotrienols have an unprecedented number of health benefits when combined with the other super nutrients in red pal oil. Red palm oil is an overall immune system tonic that improves liver detoxification and can help treat non-alcoholic fatty liver disease. It protects against osteoporosis and arthritis (Rink, 2011).

National Institutes of Health found that red palm oil reduces risk of stroke by 50% due to its protective effects on brain cells. The super vitamin E in red palm oil stimulates blood flow to the brain and also defends against Alzheimer's disease (Rasool, 2008).

Occurrence and Pollution

Polycyclic aromatic hydrocarbons are lipophilic, meaning they mix more easily with oil than water. The larger compounds are less water soluble and less volatile. Because of these properties, polycyclic aromatic hydrocarbons in the environment are found primarily in soil, sediment and only substances: natural crude oil and coal deposits contain significant amount of polycyclic hydrocarbons, arising from chemical conversion of natural product molecules such as steroids to aromatic hydrocarbon. They are also found in processed fossil fuels, tar and various edible oil (Bostron *et al*., 2002).

Polycyclic aromatic hydrocarbons are one of the most widespread organic pollutants. In addition to their presence in fossil fuels, they are also formed by incomplete combustion of carbon containing fuels such as wood, coal, diesel, fat, tobacco and incense. Different distributions of polycyclic aromatic hydrocarbon in both relative amounts of individual polycyclic hydrocarbon and in which isomers are produced. Thus, coal burning produced a different mixture than motor-fuel combustion of forest-fire making the compounds potentially useful as indications of the burning history (Bostron *et al*., 2002).

(Cheenkachorn, 2013) investigated the use of palm oil as base oil for an environmental friendly lubricant for small four – stroke motorcycle engines. (Masjuki *et al.*, 2010) study the comparative of wear, friction, viscosity, lubricant degradation, and exhaust emissions with palm oil and commercial lubricating oil. Their results revealed that the palm oil based lubricating oil exhibited better performance in terms of friction. (Bekal, 2012) investigated the substitution of mineral oil with vegetable oil as lubricant in a CI engine. Their experiments were conducted with neat pongamia oil and blend of panama oil and mineral oil in different proportions. (Navindgi *et al.,* 2013) revealed that addition of rapeseed oil to mineral based lubricant reduces the friction coefficient in high term. (Hassan *et al.*, 2006) who works on the possibility of producing lubricating oil from vegetable oil with palm oil.

Polycyclic aromatic hydrocarbons are one of the typical persistent organic compounds (POPS) featured in regional and global cycling. Polycyclic are emitted mainly into the atmosphere, absorbed to particles, and may then be transported over long distances where they can be detected. Polycyclic aromatic hydrocarbons are thus ubiquitous environmental pollutants that are generally found in elevated levels near emission sources. (Brevik *et al.,* 2009). According to (Holoubek *et al.,* 2011) state the rate of polycyclic aromatic hydrocarbons is of great environment concern due to their toxic, mutagenic and carcinogenic properties. It depends on several factors such as atmospheric photolysis, sorption, water and lipid solubility, chemical oxidation, violatisation and microbial degradation. Atmospheric polycyclic aromatic hydrocarbon deposited as a major contributor to polycyclic aromatic hydrocarbons in soil. Polycyclic aromatic hydrocarbons found in soil around a flow station are used for their estimation and source prediction. (Moritho *et al.,* 2008).

Clark *et al.*, 2008 found that photodegradation of pyrene in aqueous solutions increases as the ionic strength increases and decreases with increase in concentration of humid acid or decreases, (Tsa *et al.,* 2010) state that polycyclic aromatic hydrocarbons are widespread containment which can be deposited onto particles formed during an incomplete combustion of organic matter in the presence of air, since several polycyclic aromatic hydrocarbons and some of their degradation products (oxygenated and nitrated PAHs) are known to have high carcinogenic and mutagenic potentials. Correa, S. M. *et al.*, 2006 state that the identification data of individual polycyclic aromatic hydrocarbons obtained in separate fractions in which the gaseous and polycyclic aromatic hydrocarbons phase was determined in diesel fumes (ON), and in B_2, B_5 and B_{20} mixtures. Diesel engine exhaust emissions are of a major interest to national and international levels as demonstrated by numerous publication resulting from analyses of gas and particular phase, evaluation of occupational and environmental exposure toxicology and epidemiological studies.

Storelli *et al.,* 2003 states that higher levels of poly aromatic hydrocarbons were also observed in smoked seafood. (Purcaro *et al.,* 2006) investigated whether deep frying with different oils under different conditions led to the development of polycyclic aromatic hydrocarbon on either in the oil or in the fried product.

Toxicity of Polycyclic Aromatic Hydrocarbons

Acute effect attributed to polycyclic aromatic hydrocarbons exposure such as headache, nausea, respiratory and dermal irritation are probably caused by other agents. Since polycyclic aromatic hydrocarbons have low acute toxicity. Other more acutely toxic agents probably cause the acute symptoms attributed to polycyclic aromatic hydrocarbons, hydrogen sulphide in roofing tars and sulphur dioxide in foundries are examples of contaminants, acutely toxic contaminants. Naphthalene, the most abundant constituent of coal tar is a skin irritant and its vapour may cause headache, nausea, vomiting effects reported from occupational exposure to polycyclic aromatic hydrocarbons include: chronic bronchitis, cough irritating, dermatitis, reported health associated with chronic exposure to coal tar and its by products (e.g. PAHs)(Bocio *et al.*, 2003).

- Skin: Burns, warts on sun exposed area with progression to cancer.
- Eyes: Irritation
- Respiratory System: Cough, bronchitis
- Gastrointestinal System: Cancer of the lip

A relevant patient history might include the following:

- Diet, especially char boiled meats
- Occupational History
- Alcohol consumption
- Smoking habits

The most common step for determine exposure to polycyclic aromatic hydrocarbons involves examine tissues, blood and urine for the presence of metabolites. Pyrene is commonly found in polycyclic aromatic hydrocarbon mixtures and its urinary metabolites, 1- hydroxypyrene, has been used as an indicator of exposure to polycyclic aromatic hydrocarbon chemical (Becher *et al.*, 2005)

Table 2: Legislative Limits for Polycyclic Aromatic Hydrocarbons in Food (EPA, 2008), (WHO, 2007)

Foodstuffs	EPA (µg/kg)	WHO (µg/kg)
Oils and fats intended for direct human consumption or use as an ingredient in foods	2.0	3.0
Smoked meats and smoked meats products	5.0	6.0
Muscle meat of fish	2.0	2.0
Processed cereal-based foods for infants and young children	1.0	2.0
Dietary foods for special medical purpose intended specifically for infants	1.0	2.0

The aim of this measure is to provide polycyclic aromatic hydrocarbon contamination in foods to investigate the product and determine the polycyclic aromatic hydrocarbon levels.

MATERIALS AND METHODS

Materials

Materials used for this experiment include: sample of palm oil, dilute chloromethane, Potassium hydroxide, Methanol, Deonized water, Hexane, Anhydrous sodium sulphate, Silica gel, Acetonitoic

Apparatus

These include: Extraction bottle, ultrasonic sonicator, rotary evaporator, water bath, Hp 5890 GC – FID

Experimental Procedure
Sample Collection

The samples were collected from 3 major markets each from the 5 Local Government Areas making up the Ohafia Agricultural Zone of Abia State. The LGA markets includes: Sample 1: Oriendu Ovim, Isukwuato LGA, Sample 2: Okagwe, Ohafia LGA, Sample 3: Okoko Item, Bende LGA, Sample 4: Akpuneru Leru, Umunneochi LGA, Sample 5: Eluama, Isuikwuato LGA, Sample 6: Nkwoachara Uturu, Isuikwuato LGA, Sample 7: Uzuakoli,, Bende LGA, Sample 8: Akawa Nneato, Umunneochi LGA, Sample 9: Eke Isuochi Nkwoagu, Umunneochi LGA, Sample 10: Ibom Arochukwu, Arochukwu LGA, Sample 11: Atani Ihe Ihechiowa, Arochukwu LGA, Sample 12: Asaga, Ohafia LGA, Sample 13: Abuma Ututu, Arochukwu LGA, Sample 14: Omeziebiri Igbere, Bende LGA, and Sample 15: Ebem, Ohafia LGA

Instrumental Analysis

The polycyclic aromatic hydrocarbon analysis carried out was by means of pre programmed HP 5890 gas chromatograph technique with flame ionization detector (GC-FID). The operation conditions were as follows:

The oven temperature was set initially at 100^0C (0.5min hold), a ramp at 15^OC/min to 200^OC, then 20^OC/min to 300^OC, final oven temperature 300^OC, the detector was set at 340^OC and injector was set at 250^OC. Helium gas was used as the carrier gas and hydrogen and air was used as ignition gas.

Analytical Procedure

10g of the sample was weighed into air extraction bottle and 20ml of DCM was added and sonicated in an ultrasonic sonicator for 2 hours. The extract was concentrated to 2ml in a rotary evaporator. 20ml 0.5m KOH in 100ml of methanol was added and the mixture was refluxed form 1 hour in a water bath at 60^OC. 20ml deionized water was added and extracted with hexane (200ml). The extract was dried over anhydrous sodium sulphate and the extract was concentrated at 60^OC in a rotary evaporator to 2ml. The extract was passed through a silica gel column which had been pre-conditioned with hexane. The extract was eluted with 20ml of hexane for aliphatic fractions. To same column, 20ml of DCM was added for the elution of PAHs and the fluent was concentrated to 1ml and solvent exchange with 1ml of acetonitrile $1\mu l$ of the extract was injected into a pre-programmed HP 5890 GC equipment with FID.The concentration of the PAHs was calculated from the peak of the calibration standards

RESULTS AND DISCUSSION
Results

The results of the GC-FID analysis of the polyaromatic hydrocarbon contamination of the palm oil samples from the five Local Government Areas of the Abia North Agricultural Zone are shown in Tables 4.1-4.5 this analysis are shown below:

Table 3: Seventeen PAHs and Analytical Result for Isuikwuato Local Government Area, Abia State.

L.G.A	Isuikwuato LGA		
	Ovim Oriendu	Eluama	Nkwoachara Uturu
Parameters	Sample 1	Sample 5	Sample 6
PAH Profile			
Naphthalene			
2 Methylnapthlene	ND	ND	ND
Acenapthene	ND	ND	ND
Acenaphthylene	ND	ND	ND
Fluorene	ND	ND	ND
Phenanthrene	0.02	0.01	ND
Anthracene	ND	ND	ND
Fluoranthene	ND	ND	ND
Pyrene	ND	ND	ND
Benz(a) anthracene	ND	ND	ND
Chrysene	ND	ND	0.02
Benzo(b) flyuoranthene	ND	ND	ND
Benzo(k) fluoranthene	ND	ND	ND
Benzo(a) pyrene	ND	ND	ND
Dibenz (a,h) anthracene	ND	ND	ND
Benzo(g,h,i) perylene	ND	ND	ND
Indeno(1,2,2-cd) pyrene	ND	ND	ND
TOTAL (μg/kg)	0.02	0.01	0.02

Table 4: Showing Result for Bende Local Government Area

L.G.A	Bende LGA		
	Okoko Item	Uzuakoli	Omezibiri Igbere
Parameters	Sample 3	Sample 7	Sample 14
PAH Profile			
Naphthalene			
2 Methylnapthlene	ND	ND	ND
Acenapthene	ND	ND	ND
Acenaphthylene	ND	ND	ND
Fluorene	ND	ND	ND
Phenanthrene	0.01	ND	ND
Anthracene	ND	0.01	ND

Fluoranthene	ND	ND	ND
Pyrene	ND	ND	ND
Benz(a) anthracene	ND	ND	ND
Chrysene	ND	ND	ND
Benzo(b) flyuoranthene	ND	ND	ND
Benzo(k) fluoranthene	ND	ND	ND
Benzo(a) pyrene	ND	ND	ND
Dibenz (a,h) anthracene	ND	ND	ND
Benzo(g,h,i) perylene	ND	ND	ND
Indeno(1,2,2-cd) pyrene	ND	ND	ND
TOTAL (μg/kg)	0.01	0.01	<0.01

Table 5: Result for Arochukwu Local Government Area

L.G.A	**Arochukwu LGA**		
	Ibom Arochukwu	Ataniihe Ihechiowa	Abuma Ututu
Parameters	Sample 10	Sample 11	Sample 13
PAH Profile			
Naphthalene			
2 Methylnapthlene	ND	ND	ND
Acenapthene	ND	ND	ND
Acenaphthylene	ND	ND	ND
Fluorene	ND	ND	ND
Phenanthrene	ND	ND	ND
Anthracene	0.1	ND	0.2
Fluoranthene	ND	ND	ND
Pyrene	ND	ND	ND
Benz(a) anthracene	0.1	ND	0.2
Chrysene	ND	ND	ND
Benzo(b) flyuoranthene	ND	ND	ND
Benzo(k) fluoranthene	ND	ND	ND
Benzo(a) pyrene	ND	ND	ND
Dibenz (a,h) anthracene	ND	ND	ND

Benzo(g,h,i) perylene	ND	ND	ND
Indeno(1,2,2-cd) pyrene	ND	ND	ND
TOTAL (µg/kg)	0.2	<0.01	0.4

Table 6: Result for Ohafia Local Government Area

L.G.A	**Ohafia**		
	Okagweu	Asaga	Ebem
Parameters	Sample 2	Sample 12	Sample 15
PAH Profile			
Naphthalene			
2 Methylnapthlene	ND	ND	ND
Acenapthene	ND	ND	ND
Acenaphthylene	ND	ND	ND
Fluorene	ND	ND	ND
Phenanthrene	ND	ND	ND
Anthracene	ND	ND	ND
Fluoranthene	ND	ND	ND
Pyrene	ND	ND	ND
Benz(a) anthracene	ND	ND	ND
Chrysene	ND	ND	ND
Benzo(b) flyuoranthene	ND	ND	ND
Benzo(k) fluoranthene	ND	ND	ND
Benzo(a) pyrene	ND	ND	ND
Dibenz (a,h) anthracene	ND	ND	ND
Benzo(g,h,i) perylene	ND	ND	ND
Indeno(1,2,2-cd) pyrene	ND	ND	ND
TOTAL (µg/kg)	<0.01	<0.01	<0.01

Table 7: Result for Umunneochi Local Government Area

L.G.A	**Umunneochi LGA**		
	Akpunaeru Leru	Akawa Nneato	Eke Isuochi
Parameters	Sample 4	Sample 8	Sample 9
PAH Profile			
Naphthalene			
2 Methylnapthlene	ND	ND	ND
Acenapthene	ND	ND	ND
Acenaphthylene	ND	ND	ND
Fluorene	ND	ND	ND
Phenanthrene	ND	0.1	0.02
Anthracene	0.1	ND	0.2
Fluoranthene	ND	ND	ND
Pyrene	ND	ND	ND
Benz(a) anthracene		ND	0.01
Chrysene	ND	ND	ND
Benzo(b) flyuoranthene	ND	ND	ND
Benzo(k) fluoranthene	ND	ND	ND
Benzo(a) pyrene	ND	ND	ND
Dibenz (a,h) anthracene	ND	ND	ND
Benzo(g,h,i) perylene	ND	ND	ND
Indeno(1,2,2-cd) pyrene	ND	ND	ND
TOTAL (µg/kg)	<0.01	0.1	0.03

The Federal Government has set regulations to protect people from the possible health effects of eating, drinking, or breathing PAHs. The following are amounts of individual PAHs that are not likely to cause any harmful health effects (EPA, 2008), (SON, 2007).

Table 8: EPA and WHO Standard Limits for Polyaromatic Hydrocarbons in Foods and Related Products

Compound	**EPA (mg/kg)**	**SON (mg/kg)**
Phenanthrene	0.1	0.1
Anthracene	0.3	0.2
Fluorene	0.04	0.06
Chrysene	0.02	0.03
Benz(a) anthracene	0.03	0.05
Benzo(b) fluorathene	0.02	0.04

Dibenz(a,h) anthracene	0.03	0.03
Indenol(1,2,3-cd) pyrene	0.04	0.04
Benzo(k) fluorathene	0.10	0.02
Acenaphthene	0.06	0.04
Pydrene	0.03	0.06
Benzo(ghi)perylene	0.03	0.05
Benzo(e) pyrene	5.10	6.0
Benzo(a) pyrene	2.0	3.0
Dibenzo(a,h) pyrene	5.0	6.0

DISCUSSION

From the observation, it shows that some samples contaminate few polycyclic aromatic hydrocarbons.

Isuikwuato: The PAH detected in the samples from Isuikwuato Local Government Area were Phenanthrene 0.02 µg/kg in Ovim Oriendu, 0.01 µg/kg in Eluama, and chrysene 0.02 µg/kg in Nkwoachara Uturu. Phenanthrene is a tricyclic aromatic hydrocarbon derived from coal tar. It is colourless, insoluble in water, it is used in the synthesis of dyes, explosive and drugs. Phenanthrene can enter the body through breathing and contaminate food and water. It affects the organs including the kidney, liver and fat but it leaves the body through urine and feaces (Ramesh *et al*., 2004) while chrysene is a polycyclic aromatic hydrocarbon. It is carcinogenic to human health. Chrysene causes liver and lung tumor and malignant Lymphoma in mice. Dermal exposure causes skin carcinomas mice (Wenzel *et al*., 2000). The results show that the level of PAHs detected in these samples is far negligible based on EPA standards for foods. This means that the samples are safe. The contamination may be from smoking during processing.

Bende: Fluorene 0.01 µg/kg was detected in the sample from Okoko Item Bende Local government Area. Flourine is a polycyclicaromatic hydrocarbon obtained from coal tar. The fluorine molecule is nearly planar, although each of the two benzene rings is coplanar with central carbon. It is prepared by the reduction of diphenylene with zinc. It has an intense orange colour. The purification of fluorine exploits acidity and the low solubility of its sodium derivatives in hydrocarbon solvents. Flourene causes birth defects, also damages the liver, and affects the abdominal region (Toriba *et al*., 2003). In this sample, the level of fluorine is 0.01 µg/kg which is far lower than the standard level and so negligible. This means that the sample is safe. The contamination may be due to contaminated water that is used for squeezing the palm fruit during processing.

Arochukwu: The PAH determined from the samples from Arochukwu Local Government Area were Anthracene 0.1 µg/kg in Ibom Arochukwu and Benz(a) anthracene 0.2 µg/kg in Abuma Ututu; Anthracene which is also a member of tricyclic aromatic hydrocarbon. It also enters the body through breathing whereby it irritates the throat, and lungs causing coughing and wheezing. Anthracene causes itching and skin rash (Bosetti *et al*., 2007) while benz(a)anthracene is an odourless, colourless to yellow brown flakes. It is found in coal tar, roasted coffee, smoked foods, automobile exhaust, and is formed as an intermediate during chemical manufacturing. It affects when inhaled and eyes contact (Bostron *et al*., 2002). From these two PAHs the standard is lesser whereby the samples are safe. The contamination may have come through the leaves that is used to cover the palm fruit when cooking.

Umunneochi: The PAHs detected from the samples from Umunneochi Local Government Area were phenanthrene 0.1 µg/kg in Akawa Nneato, 0.02 µg/kg in Eke Isuochi and benz(a)anthracene 0.01 µg/kg. Phenanthrene is polyaromatic hydrocarbon derived from coal tar which enters the body through breathing and contaminated food and water. It affects the kidney, liver, fat and leaves the body through urine and feaces (Ramesh *et al*., 2004) while benz(a)anthracene is a colourless and odourless which affects the eyes by inhalation (Bostrom *et al*., 2002). For these PAH, they are lower than the standard level and they are safe. The contamination is through contaminated drum that is used for cooking the palm fruit during processing.

Ohafia: No PAH were detected in Ohafia Local Government Area. This means that the samples from Ohafia are safe.

CONCLUSION

The results of this analysis shows that the concentrations of the polycyclic aromatic hydrocarbons (PAHs) in palm oil samples was that chrysene was found in sample 6- Nkwoachara Uturu in Isuikwuato Local Government Area with level of (0.02 µg/kg), Benz(a) anthracen in sample 9- Eke Isuochi Nkwoagu in Umunneochi Local Government Area, (0.01 µg/kg) and Sample 10 – Ibom Arochukwu, Arochukwu Local Government Area, (0.1 µg/kg), Sample 13- Abuma Ututu in Arochukwu Local Government Area, (0.2 µg/kg). These polycyclic aromatic hydrocarbons that was mentioned are carcinogenic but their concentrations were negligible based on EPA and WHO standards therefore they are not harmful to human health which means all the palm oil samples are fit for consumption.

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