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INVESTIGATION OF POLYCYCLIC AROMATIC HYDROCARBON CONCENTRATION IN ROASTED PLANTAIN, ROASTED MEAT AND SMOKED FISH IN ONDO, NIGERIA

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ABSTRACT
Polycyclic Aromatic Hydrocarbons (PAHs) are produced as a result of incomplete combustion and pyrolysis of organic materials. Roasting and smoking are some of local food processing methods that are commonly adopted in this part of the world which give rise to PAHs occurrence in food. This study therefore, evaluate the level of Polycyclic Aromatic Hydrocarbons present in roasted plantain, roasted meat and smoked fish which were obtained from the open market in Sabo Ondo, Ondo State, Nigeria. The proximate analysis was done using the method described by AOAC and the levels of total PAHs obtained using GC/FID. From the proximate analysis of the three samples, their moisture content ranged from 19.390-58.310%, Ash content ranged form 6.290-13.285%, Fat content ranged from 4.320-19.270%. The protein content ranged from 6.070-44.855%, Crude fibre is from 0.200-0.420% while the carbohydrate value is between 8.885-22.090%. The Gas chromatography analysis shows that sixteen compounds of polycyclic aromatic hydrocarbon were detected in each sample. The amount of PAHs decreases from dibenzo(a,h) anthracene 0.009919µg/kg to fluoranthene 0.104704µg/kg in roasted plantain while the PAH amount decreases from dibenzo(a,h) anthracene 0.009923µg/kg to anthracene 0.137978µg/kg in smoked meat and in smoked fish it decreases from chrysene 0.072158µg/kg to dibenzo(a,h) anthracene 0.00000. The total amount of PAHs in the samples were 2.148937, 3.301331 and 1.225625µg/kg for roasted plantain, smoked meat and smoked fish respectively.
Key words: Proximate, roasted, smoked, PAHs, GC/FID, Carcinogenic.

INTRODUCTION

Polycyclic Aromatic Hydrocarbons (PAHs) are group of organic chemicals that are produced during the incomplete burning of fuels, garbage or the pyrolysis of other organic substances such as tobacco, plant material or meats (Nawrot et al, 1999; Philips, 1999; Knize et al, 1999). They can also be found in coal tar, bitumen, crude oil, creosote and roofing tar. Some of these PAHs are manufactured for research or are used in medicines, dyes and plastics.

The distribution of PAHs in the environment is extensive and the general public may be exposed to PAHs found in soil/dust, air, water, food or household products (Weislo, 1998; WHO, 1998; Berko, 1999). Polycyclic Aromatic Hydrocarbons are widely distributed in the environment and human exposure to them is unavoidable. A number of them, such as benzo(a) pyrene are carcinogenic and mutagenic, and they are widely believed to make a substantial contribution to the overall burden of cancer in humans. PAHs presence in the environment is reflected in their presence at detectable levels in many types of uncooked food (Olabemio et al 2013). In addition, cooking processes can further increase the level of PAHs in food (SCF, 2002). PAHs can also be formed during the canning and processing of raw food prior to cooking. Several studies have been carried out to determine the levels of exposure to PAHs from representative human diets, and the proportion of the overall burden of environmental exposure to PAHs that is attributable to the diet.

It is therefore concluded that the diet is the major source of human exposure to PAHs (WHO, 1998; SCF, 2002). Bio-monitoring procedures have been developed to assess human exposure to PAHs and these have also indicated that diet is a major source of exposure. Studies have shown that high levels of PAHs are found, for example, in meat cooked at high temperatures, such as grilling or barbecuing and in smoked fish (Larsson, B.K. et al 1983; ECSC, 2002).

A significant accumulation of PAHs in soil, plants and water bodies occurs when the release of PAHs into the environment exceeds their degradation capacity. Soil and water contamination originates mainly from PAHs emissions to the atmospheres, which reach the soil and water bodies via precipitation (Abass et al, 2007).

Traces of PAHs have been detected in many foods including vegetable oils, fruits, sea foods, grilled and roasted meat, smoked fish, tea and coffee. In particular benzo (a) pyrene has been found in these samples at concentration levels between 0.1 and 100μgkg^{-1} (Stall and Einsenbrand, 1988, Kayali-Sayadi et al, 1996).

Food pollution is due to deposition of PAHs from the air or water or results from preservation, drying and cooking procedures (Stall and Einsenbrand, 1998 and Rivera et al, 1996). Roasted plantain, roasted meat and smoked fish are commonly consumed by all classes of people in this part of the country, the old and young alike. Because of adverse health effect that high concentration of PAHs may cause, this study was carried out to investigate the concentration of PAHs present in these processed foods.

MATERIALS AND METHODS

Roasted plantain, meat roasted and smoked fish samples were all purchased in an open market in Sabo Ondo town, Ondo state, Nigeria. The samples were properly dried in the oven for 3hours at 50°C and then pulverized in the laboratory with the aid of analytical grinding machine to ensure homogenization.

10.0g of the pulverized sample mixed with anhydrous sodium sulphate salt was soxhlet extracted with n-hexane and dichloromethane in the ratio 3:1.for 6hours. The GC analysis was done using the Hewlett Packard 5890 series II Plus GC equipped with a 30m X 0.25μm film thickness PONA (parraffins, olefins, naphathalenes and aromatics), cross linked methyl siloxane capillary column. A flame ionization detector (FID) detected separated components. The carrier gas was nitrogen flowing at the rate of 300ml/min. The GC oven was at 60°C for 5min, then programmed at 15°C/min to a final hold at 320°C, the final temperature was held for about 4min. The peaks were integrated electronically and identification was based on retention times and comparison with standards. The peak integration was achieved using hp chemstation software.

RESULTS AND DISCUSSION

The results of proximate analysis of the three samples as presented in Table 1 show that, their moisture content ranged from 19.39 - 58.31. The high moisture content of roasted ripe plantain may be due to the ripening effect which converts the starch to water and sugar. The ash content ranged from 6.29 - 13.285. The fat content ranged from 4.32 - 19.27. The protein content ranged from 6.07 - 44.855.The crude fibre ranged from 0.20 -0.42 while the carbohydrate ranged from 8.885 - 22.09. The high carbohydrate reported for plantain in this study corroborated the report of Ketiku (1973).

Table 1: Proximate composition of the samples (mean)

Sample	Moisture content (Mean %)	Ash content (Mean %)	Fat content (Mean %)	Protein content (Mean %)	Crude fibre (Mean %)	Carbohydrate content (Mean %)
Roasted plantain	58.31±0.29	8.295±0.15	4.32±0.13	6.07±0.01	0.42±0.14	22.09±0.22
Roasted meat	28.14±0.01	13.29±0.06	19.27±0.06	29.42±0.03	0.40±0.03	8.89±0.04
Smoked fish	19.39±0.55	6.29±0.10	9.51±0.56	44.855±0.15	0.20±0.06	19.755±0.01

From Table 2, which shows the result of gas chromatography analysis, the amount of PAHs decreases form dibenzo (a,h) anthracene 0.009919 μg/kg to fluoranthene 0.104704 μg/kg in

roasted plantain, while the PAHs amount decreases from dibenzo (a,h) anthracene 0.009923 to anthracene 0.137978 µg/kg in roasted meat and in smoked fish, it decreases from chrysene 0.721580^{-1} to dibenzo (a,h) anthracene 0.00000. The total PAHs amount in the three samples is in the following order: Sample B>Sample A> Sample C.

Table 2: Gas chromatography of the samples

S/N	PAHs	Roasted plantain (µg/kg)	Roasted meat (µg/kg)	Smoked fish (ug/kg)
1.	Naphthalene	0.52111	0.593576	0.371568
2.	Acenaphthylene	0.341426	0.545687	0.013156
3.	Acenaphthane	0.566345	0.180420	0.417857
4.	Fluorene	0.274571	0.375792	0.594394
5.	Phenanthrene	0.459934	0.505580	0.399041
6.	Anthracene	0.135918	0.137978	0.358736
7.	Fluoranthene	0.104704	0.373842	0.433048
8.	Pyrene	0.183794	0.615007	0.115363
9.	Benzo(a)anthracene	0.577325	0.729813	0.275821
10.	Chrysene	0.152429	0.195212	0.721580
11.	Benzo(b) fluoranthene	0.537211	0.264286	0.485246
12.	Benzo(k) fluoronthene	0.462050	0.462470	0.224342
13.	Benzo(a) pyrene	0.488659	0.522865	0.316888
14.	Indeno(1,2,3-cd) pyrene	0.258811	0.293124	0.125574
15.	Dibenzo(a,h) anthracene	0.991903	0.009923	0.00000
16.	Benzo(g,h,i) perylene	0.4065514	0.411068	0.114858
	Total PAH	2.1489370	3.301332	1.225625

Furthermore, in roasted plantain, Acenaphthene (0.566345 µg/kg) has the highest value among the 3-rings PAHs present while Anthracene (0.135918 µg/kg) has the lowest value. Benzo(a) anthracene (0.577325 µg/kg) is the highest for 4-rings PAHs present and fluroanthene (0.104704 µg/kg) the lowest concentration. Among the 5-rings PAHs, dibenzo(a,h) anthracene 0.009919 µg/kg has the largest concentration while Benzo(k) fluoranthene 0.462050 µg/kg the lowest. Benzo(g,h,i) perylene 0.406514 µg/kg recorded the highest value as against indeno (1,2,3-cd) pyrene (0.258811 µg/kg) which has the lowest.

For roasted meat, Acenaphthylene (0.545687 µg/kg) has the highest concentration among the 3-rings PAHs as against Anthracene (0.137978 µg/kg) which is the lowest. Benzo(a) anthracene (0.729813 µg/kg) is the highest for 4-rings PAHs while Chrysene(0.195212 µg/kg) has the least value. From the 5-rings PAHs, dibenzo(a,h) anthracene (0.009923 µg/kg) has the highest concentration and benzo(b) fluoranthene (0.264286 µg/kg) the lowest. Benzo(g,h,i) perylene (0.411068 µg/kg) has the highest concentration among the 6-rings PAHs as against Indeno(1,2,3-cd) pyrene (0.293124 µg/kg) the lowest value.

In smoked fish, among the 3-rings PAHS, fluorene (0.594394 µg/kg) has the highest concentration while Acenaphthylene (0.013156 µg/kg) the least. Chrysene (0.721580 µg/kg) has the largest value among the 4-rings PAHs as against Pyrene (0.115363 µg/kg) which is the lowest. For the 5-rings PAHs, benzo (b) fluoranthene (0.048525 µg/kg) has the highest concentration while dibenzo(a,h) anthrancene 0.00000 has no value at all. Indeno (1,2,3-cd) pyrene (0.125574 µg/kg) has the highest concentration among the 6-rings PAHs as against Benzo (g,h,i) perylene (0.114858 µg/kg) which is the lowest.

The total PAHs concentration for roasted meat (3.30133056 µg/kg) is directly related to the fat content of the same sample (19.27%). This is in accordance with (SCF, 2002). The relationship between fat contents and the PAHs concentration were inconsistent among other samples in the study.

The carbohydrate content of sample roasted plantain is 22.09% while the total PAH concentration is 2.1489370 µg/kg. Carbohydrate content for roasted meat is 8.88% and total PAH concentration

of 3.301332 µg/kg. For smoked fish, carbohydrate content is 19.75% with PAH concentration of 1.225625 µg/kg.

Table 3. Molecular PAHs indices ratio

	plantain	meat	fish
Phen/Anth	3.3839	3.6669	11.1235
Fl /Fl + Py	1.1838	1.6150	1.1154
Fl / Phen	0.2277	0.7394	1.0852

Phen = Phenanthrene; Anth = Anthracene ; Fl = Fluoranthrene ; Py = Pyrene

It is generally accepted that the sources of PAHs are categorized in to two origins: Pyrolytic (incomplete combustion of organic matters – combustion of fossil fuel, Vehicular engine combustion, smelting, waste incinerators, forest fire and coal combustion) and Petrogenic (unburned petroleum and its product – gasoline, kerosene, diesel, lubricating oil and asphalt). Several molecular ratios such as Phenanthrene/Anthracene (Phen/Anth) Fluoranthrene/Fluoranthrene + Pyrene (FI/FI +Py) Fluoranthrene/ Phenantrene (FI/Phen) have been commonly use as a way of determining origin of PAHs sources.

The PAH ratio as presented in Table 3 shows that Phen/Anth in this study is in the range 3.667-11.124 The value is much lower than 10 in two of the samples i.e. in roasted plantain and smoked meat which is generally considered indicative of a predominance pyrogenic sources, while in smoked fish, the value is higher than 10 which is a characteristic of petrogenic sources (Tolosa el al. 2003). The Phen/Anth concentration ratios indicate that the PAHs in this study are derived from pyrolytic rather than petrogenic sources.

PAH isomer pair ratio Fluoranthene/ Fluoranthene + Pyrene (FI/FI + Py) has also been used as distinct chemical tracer to infer possible source of PAHs in environmental sample (Yunker el ta 2002). Yunker et al. (2002) stated that the PAH isomer ratio measurement FI/FI + Py of less than 0.4 implies petrogenic, 0.4-0.5 suggests pyrogenic sources and more than 0.5 imply combustion of coal, grass and wood. The FI/FI + Py ratio shows that petrogenic and pyrogenic sources contributed to the distribution of these contaminants but predominantly pyrogenic.

CONCLUSION

From the results obtained in this study, it is shown that, the total PAHs concentration deposited on all the three samples under study, roasted ripe plantain, roasted meat and smoked fish were contributed by petrogenic and pyrogenic sources Nevertheless, high consumption of these food items may be detrimental to human health.

REFERENCES

Bartle.K D, (1991) Analysis and Occurrence of PAHs in food. In: Creaser C S, Purchase R, editors. Food contaminants: Sources and Surveillance. Cambridge: Royal Society of Chemistry: 41-60

Berko H.N. (1999). Polycyclic Aromatic Hydrocarbons in Australia, Environment Australia. 55

Hawthorne,S B and Miller.D J. 1994). Polycyclic Aromatic Hydrocabons level in roasted food. J.Anal. Chem; 66(22), 40-50.

World Health Organization (WHO).(1998) Environmental Health Criteria 202, Selected Non-heterocyclic PAHs, Geneva:
Available from: URL: http://www.inchem.org/documents/ech/ehc/ehc/202:htm

IPCS, (1998). ″Selected Non-heterocyclic polycyclic Aromatic Hydrocarbon″ Environmental Health Criteria 202, International Programme on Chemical Safety, WHO, Geneva.

Kayali,M N, Rubio-Barroso. S, and Polo-Diez, L M. (1995). Polycyclic Aromatic Hydrocabons in smoked food products and commercial liquid smoke flavouring food. J. Chromatogr. Sci, 33(4), 181.

Kayali-Sayadi, M N, Rubio-Barosso.S, Beceiro-Roldan. C and Polo-Diez. L M. (1996). Uptake of trace elements and PAHs by fruits and vegetables from contaminated soil. J. liq. Chromatogr. Relat. Tech. 19(19), 3135.

Ketiku O.A (1973), Chemical Composition of unripe and ripe plantain J. Sci. Food Agric 24: 703-707.

Muller P, (1997).Scientific Criteria Document for Multimedia Standards Development Polycyclic Aromatic Hydrocarbons (PAH); Part 1: Hazard Identification and Dose-Response Assessment, Standard Development Branch, Ontario Ministry of Environment and Energy.

Nawrot. P S, Vavasour E J and Grant D L.(1999) Food irradiation, heat treatment, and related processing techniques: Safety evaluation. In: Van der Heijden K, Younes M, Fishbein L, Miller. S, editors. International Food Safety Handbook. New York: Marcel Dekker: 306-8.

Olabemiwo M.O, Adedosu T.A and Omodara N.B (2013). Proximate analysis and polycyclic aromatic hydrocarbon levels in some selected raw food stuffs in Aroje and Owode Nigeria J. of Food Sci. and Quality management. 20: 19-28.

Scientific Committee on Foods of EC (SCF). (2002) Opinion of the Scientific Committee on Food in the risk to human health of PAHs in food. Brussels:

SCF. Annex (2002) PAHs occurrence in foods, dietary exposure and health effects. Brussels.

Tolosa, I. Stephen de M, Mohammed, R.S, Jean – Pierre. V, Jean, B and Chantal, C. (2003). Aliphatic and aromatic hydrocarbon in coastel Caspian sea sediment. Marine pollution Bulletin Vol. 48 Issues 1-2 January 2004, 44-60.

Watts,R. J (1997) Hazardous Waste Sources. Pathways and Receptors. John Willey and Sons Inc. New York 201-203.

Weislo E, (1998). Soil Contamination with Polycyclic Aromatic Hydrocarbons (PAHs) in Poland-a Review Polish J of Environmental Studies 7, (5),267-271.

Yunker, M.B, Macdonald, R.W, Vingarzan, R, Mitchell, R.H, Goyette, D.S, Stephanie (2002).PAH in the fraser River basin: a critical appraisal of PAH Ratios as indicators of PAH source and composition. Organic Geochemistry.33, 489 – 515.