RISK ASSESSMENT OF ACRYLAMIDE FOR SOME COMMONLY EATEN FRIED FOODS

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Abstract: This research aims to quantify acrylamide in commonly eaten fried foods and assess the risk associated with acrylamide concentrations in them. Selected food samples (yam, sweet potato, plantain, meat, and Irish potato) purchased from Lawanson market, Surulere, Lagos, Nigeria, were fried in Soya oil at 150 ± 2ºC. Samples were extracted, centrifuged, purified and analysed on an Agilent (1100 series) high performance liquid chromatograph coupled with ultraviolet detector. The chromatogram of acrylamide and internal standard gave better resolution when acidified water of pH 3.5 was used in the eluting solvent (acetonitrile: water (30:70)). Acrylamide concentrations for fried foods were between ≤ 3 and 720 µg kg^{-1}. Sweet potatoes fried for 20 min, had the highest concentration of acrylamide while fried meat had the lowest concentration. Acrylamide concentration of sweet potatoes fries (for both 20 and 10 min) and French fries fried for 20 min exceeded the European Union bench mark value of 500 µg kg^{-1} for acrylamide in French fries. While the acrylamide concentration in French fries (360 µg kg^{-1}) fired for 10 min was less than the benchmark value. Acrylamide levels in fried plantain, yam and meat were all below the bench mark. Estimated dietary intake (EDI) study showed that children were more exposed to acrylamide risk than adult. Though all the EDI values in this study were below 4 µg kg^{-1} body weight day^{-1} (high exposure) and 200 µg kg^{-1}body weight day^{-1} (the concentration above which morphological changes in rat nerves are observed).

Keywords: Acrylamide, sweet potatoes fries, French fries, fried plantain

Introduction

Acrylamide a toxic compound, also known as 2-Propenamide, discovered in food by researchers at the Swedish National Food Administration and Stockholm University in April 2002, has gained considerable attention in recent years as a possible carcinogenic hazard and neurotoxin (FEH, 2003). Prior to its discovery in food it has been an industrial chemical used in the production of polyacrylamide (Svensson *et al.,* 2003; Wang *et al.*, 2011). Polyacrylamide has been used in crude oil production processes, mineral processing, concrete processing, as cosmetic additives, in soil and sand treatment, coating application, textile processing and other miscellaneous use (Zovko *et al.*, 2015).

Concerns about acrylamide sterns from it wide spread occurrence as a byproduct of cooking or processing (such as frying, baking and roasting) carbohydrates rich foods (at high temperature above 120ºC) (Ubaoji and Orji, 2016). In food, acrylamide is formed from several routes. Its major route is as a result of the reaction between asparagine (amino group) and reducing sugars naturally present in carbohydrate rich at elevated temperatures-the Maillard reaction discovered by Louis Camille Maillard in 1912 (Golon *et al.*, 2014). Another route includes the reaction of Acrolein and ammonia. In the absence of asparagine, acrolein and ammonia play a role of acrylamide formation in lipid rich foods. Other routes may include a reaction between acrylic acid and ammonia in lipid rich foods. Acrolein and acrylic acid are produced by degradation of lipids (triglycerides) at high temperature. The degradation of amino acids with ammonia can give rise to acrylamide formation by thermal decomposition. Amino acids such as glutamine, cysteine and aspartic acid have also been found to produce low amounts of acrylamide (Blank *et al.*, 2005; Krishnakumar and Visvanathan, 2014).

A major concern is the conversion acrylamide to glycidamide-a much more genetically active epoxide intermediate (Ghanayem *et al*., 2005; Settels *et al.*, 2008) whose adducts to hemoglobin and DNA have been identified in animals and humans. This metabolite may be involved in the reproductive and carcinogenic effects of acrylamide (Costa *et al.*, 1995). Bioassay studies of acrylamide in food and water given to rats and mice reveals induction of excess incidences of cancer at multiple sites. Tumors of the lung, skin, thyroid, mammary gland, brain, pituitary gland and uterine walls were also observed (Klaunig, 2008). As a result of carcinogenicity in rodents, acrylamide has been classified by National Toxicology Program (NTP) to be a group 2A human carcinogen and by International Agency for Research on Cancer (IARC) as probably carcinogenic to humans (Abnet, 2007; Altissimi *et al*., 2017). Increased kidney cancer occurrence was noted in highly exposed people (Pelucchi *et al*., 2011).

Thus to protect consumers, in November 2017, benchmarks values were set for acrylamide in foods commonly found with acrylamide by the European Union (EU) and a bench mark value of 500 ug kg^{-1} was set for French Fries to be applied from 11 of April, 2018 in Europe. These values were set to control hazards due to acrylamide (EU, 2017).

Altissimi *et al*. (2017) analyzed ten selected foods in Italy for acrylamide, and French fries had the highest mean concentration of 724 µg kg^{-1}. Other pastries had concentration between 460 and 230 µg kg^{-1}. Based on the concentration of acrylamide found, the average exposure to acrylamide was 0.452 µg kg^{-1} body weight day^{-1}, the average intake at 50th percentile was 0.350 µg kg^{-1} body weight day^{-1} and the average intake at the 95th Percentile was 1.539 µg kg^{-1} body weight day^{-1} and the levels of exposures were within the range that indicate concern for health as defined by European Authority for Food Safety (EFSA).

In Nigeria and many other parts of the world, starchy food such as yam, plantain, Irish and sweet potatoes are staple foods (Fadupin and Olawale, 2010). In many cases, these foods are fried before consumption. To the best of our knowledge, there has been no study on the concentration of acrylamide in fried yam and there are only two studies on concentration of acrylamide in fried sweet potatoes (Tawfik and El-Ziney, 2008; Truong *et al*., 2014). Limited studies on acrylamide in fried plantain from Nigeria exists. Omotosho *et al.* (2017), Omotosho *et al.* (2016) quantified acrylamide and determined the effect of infrared on the reduction of acrylamide while Azeke and Chukwuedo (2011) determined the effects of two pretreatment methods on the concentration of acrylamide in fried plantains from Nigeria. The scarcity of information has therefore led to this study on determining the risk associated with the consumption of these foods. The aim

of this research was to develop a method for the analysis of acrylamide, quantify acrylamide in some fried foods and determine the risk associated with the concentration of acrylamide in fried foods commonly eaten especially in Nigeria.

Materials and Methods

The sample extraction and acrylamide determination by high performance liquid chromatography (HPLC) was carried out by modifying the method in Krishna *et al*. (2014) and changing the internal standard. Instead of using Zidovudine as internal standard, Lamivudine was used.

Reagents

Acrylamide standard (100 mg) and Lamivudine-1g (internal standard) were purchased from Sigma-Aldrich. Formic acid, Acetonitrile (HPLC grade, 2.5 L) and Methanol (HPLC grade 2.5 L) were purchased from Merck (Darmstadt, Germany) and used without further purification. Ultra-pure water was used trough out this study.

Method development on high performance liquid chromatographic (HPLC) of acrinamide

For the analysis of acrylamide, three methods were examined. Using a 50 µg mL^{-1} calibration standard, separation of acrylamide was performed quantitatively isocratic elution mode. HPLC Agilent Technologies Chemstation LC System (1100 series) equipped with a Ultra Violet detector, a standard flow cell, quaternary solvent compartment with a degasser and an auto sampler was used for this study. The chromatographic separations were performed on a C18 column (250 mm × 4.6 mm) with 5 µm particle size. The mobile phase consisted of acetonitrile and water (20:80) w/w. The absorbance was monitored at 225 nm and elution was carried out at temperature of 40^0C using a flow rate of 0.1 µg kg^{-1} min^{-1}.

The second method was like the first but the mobile phase was modified and the UV wavelength was changed. Acetonitrile and acidified water (0.1% formic acid was used to acidify the distilled water to pH of 5) (20:80) were used as the mobile phase and the wavelength of detection was reduced to 220 nm.

The third method was like the second method but the UV wavelength was changed and the mobile phase was also modified. Acetonitrile and acidified water in the ratio of 30:70. The pH of the mobile phase mixture was adjusted to 3.5 with orthophosphoric acid and the HPLC run was carried out at 225 nm wavelength. Actual calibration and analysis of acrylamide in samples were by the third method.

Sampling and sample preparation

Yam, sweet potato, hard ripe plantain, Irish potato and meat (cow beef) were purchased from a local market in the Lagos metropolis. Samples were washed dried, peeled and cut into equal sizes (9 x 9 mm**)**. The meat was boiled and cut into similar size. The samples were shared into two parts with each part consisting of one of each food sample. First part was deep fried for 10 min the second part was deep fried for 20 min at 150 ± 5^0C in Soya oil (2 L). A small portion of unused oil was left for analysis of acrylamide. After frying the samples were homogenized with a multipurpose food processor and stored at -20^{o}C prior to analysis. The used oil was also sampled for analysis of acrylamide.

Extraction

5 g of samples were weighed and were each spiked with 100 µL (10 µg mL^{-1}) of Lamivudine as internal standard. Samples were shaken on a vortex for 10 min and 10 mL^{-1} of water was added to each sample set up. Resultant mixtures were votexed for 10 min and centrifuged at 4000 rpm for 20 min. Then, the supernatants were decanted for clean up on BondElut C_{18} solid phase extraction (SPE) cartridge. Before the clean-up, the cartridges were conditioned with methanol (5 mL) and equilibrated with distilled water (5 mL). Supernatants were loaded in to cartridge and the extract was allowed to pass completely through the sorbent material and the cartridge was eluted with water (1 mL). The eluent was collected into a labeled sample vial and injected into the HPLC.

Calibration, quantification and quality control

A 1 mg mL^{-1} stock solution of acrylamide was prepared in water and used to prepare series of standard solution (2 to 25 µg mL^{-1}) by diluting the stock solution in water. Lamivudine was used as the internal standard. Internal standard method was used for calibration. Five point calibration standard was used and each calibration standard had a concentration of 1 ug mL^{-1} of Lamivudine as internal standard in them. In order to check matrix effects, samples were spiked with the internal standard to attain the same concentration as in the calibration standards. Thus all samples had 1 ug mL^{-1} of internal standard in them. Recovery studies were also carried by spiking 2 mL of acrylamide (1 ug mL^{-1}) into samples prior to extraction to attain a spiking level of 400 µg kg^{-1} before extraction. Internal standard recovery was done by comparing peak area of internal standard in samples with average peak area of internal standard in calibration standard. Limits of detection (LOD) was defined as the concentration of acrylamide that gives signal-to-noise ratio of at least 3:1 (Komthong *et al.,* 2012) as commonly used in chromatography.

Risk assessment of acrylamide in fried foods

Benchmark approach

Values obtained from quantification of acrylamide in foods were compared with target value of 500 µg kg^{-1} (EU, 2017) set by the EU for French fries.

Estimated daily intake (EDI) approach

EDI which calculates the contaminant food(s) impact base on, the quantity consumed, and the concentration of the acrylamide in the food(s) and body weight (Hanlon, Brorby and Krishan, 2016) was also determined. Estimated daily intake (EDI) values for acrylamide in Nigerian the fried foods by an adult and children (2-5 years) were calculated using the following equation: EDI (µg kg^{-1} body weight day^{-1}) = (Mean concentration of acrylamide (µg kg^{-1}) X Amount of fried snack consumed per day (kg day^{-1})) divided by the average weight of an individual (kg) Daniali, Jinap, Zaidul, & Hanifah, 2010). 60 kg was used as the average body weight of a Nigerian adult and 16.7 g for a child (aged 2-5 years) as in Oyeyiola *et al.* (2017). Amount of fried snack consumed per day (g day^{-1}) was taken as 0.08 kg day^{-1} as in Iwegbue *et al.* (2013) who studied ready to-eat snacks in Southern Nigeria but for fried meat a value of 0.180 kg day^{-1} was used as in Ekhator *et al*. (2017) who studied fried meat intake in mid-western Nigeria. Levels of acrylamide below LOD were assumed to be equal to the LOD for derive mean concentration

Results and Discussion

Method development

The first HPLC analysis of spiked standard solution was carried out according to the method of Krishnakumar and Visvanathan (2014), using acetonitrile and water (20:80 v/v) as the mobile phase and UV wavelength 225 nm but this resulted in unresolved peaks between the acrylamide standard and internal standard as shown in Fig. 1.

For the second Method, the mobile phase composition was modified to include formic acidified water. There was no significant difference between the retention times of acrylamide standard and internal standard. They were close as shown in Fig. 2.

In order to improve peak resolution, a third method was developed. In this method, the mobile phase was optimized by decreasing the pH of water and changing the ratio of acetonitrile to water. It was changed from 20: 80 in previous methods and set to 30:70 v/v. This produced well-resolved peaks with internal standard and acrylamide standard solution

having a retention time of 2.199 and 2.440 min, respectively as shown in Fig. 3. In a study of acrylamide by Singh, Singh and Raja (2010), 30:70v/v of acetonitrile to water was used though the pH of water used was not stated.

Thus, this method was adopted for calibration and analysis of all the samples in this study. A calibration curve was then obtained by plotting the relative responses of analyte (acrylamide) to internal standard against the concentration of analyte. A straight line graph with good coefficient (R^2) of 0.99487 was achieved over the whole concentration range. Krishna *et al*. (2014), in similar method had similar R^2 value (0.998) but the range in their study was between 1 – 5 µg mL^{-1}. Recovery of internal standard from sample was found to between 75 and 85% and recovery studies of acrylamide gave values between 92.66 and 99.89% recoveries.

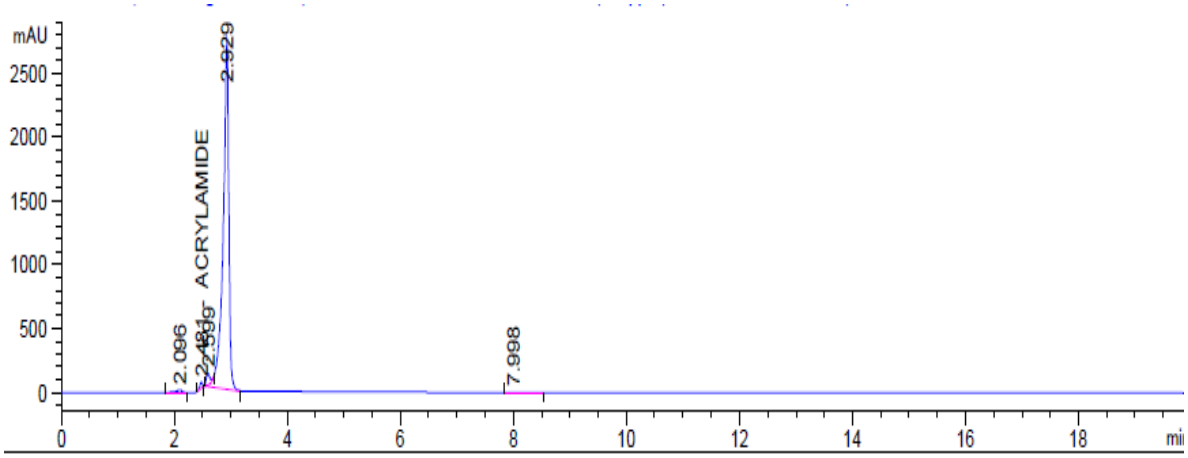

Fig. 1: Chromatogram showing unresolved peaks of acrylamide and internal standard from method 1

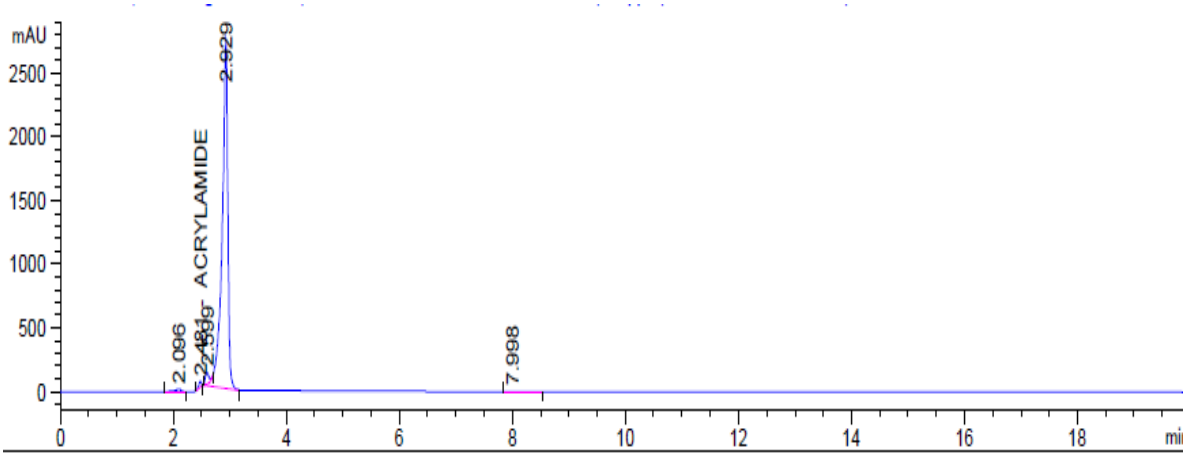

Fig. 2: Chromatogram showing unresolved peaks of acrylamide and internal standard from method 2

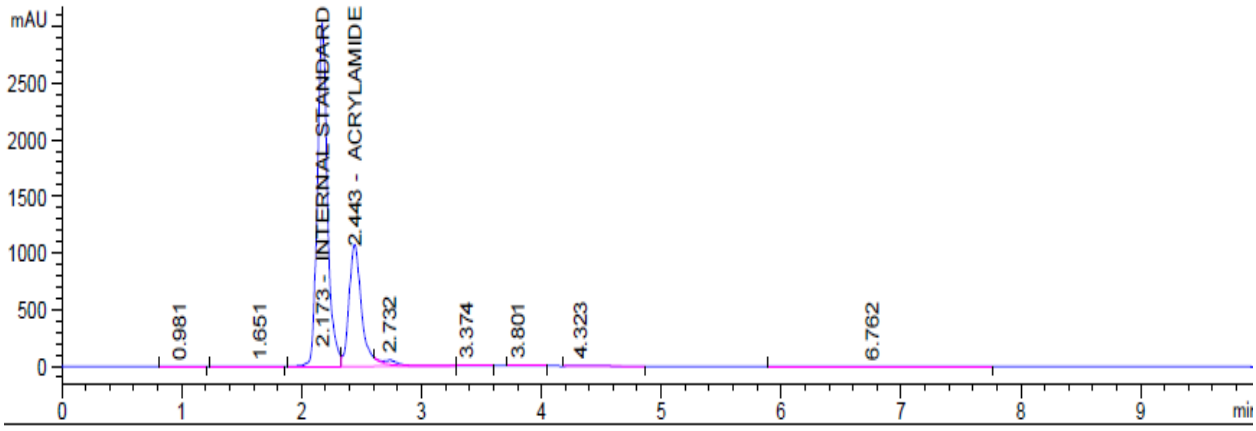

Fig. 3: Chromatogram of resolved peaks after optimization from method 3

Table 1: Concentration of acrylamide in samples

Sample type	Concentration (ug kg^{-1})		Spiked Level (ug kg^{-1})	% Recoveries of acrylamide in samples	Limit of Detection for method (ug kg^{-1})	Benchmark of acrylamide in French fries (ug kg^{-1})
	10Min	20 Min				
French fries	360.0	633.3	400	98.27	3	500
			400	99.67	3	500
Sweet potato fries	606.3	720.0				
Fried yam	≤LOD	166.7	400	92.66	3	500
Fried plantain	460.0	500.0	400	99.98	3	500
Fried meat	≤LOD	≤LOD	400	98.67	3	500
Unused oil	≤LOD	≤LOD	400	99.89	3	
Unsed oil	≤LOD	≤LOD	400	98.45	3	

Table 2: Concentration of acrylamide in various samples from other studies

Sample	Method	Acrylamide Concentration (ug kg^{-1})	Place of study	Reference
Very green unripe Plantain	HPLC-UV	49.8±24	India	Shamla & Nisha (2017)
Light green unripe Plantain		185.6 ± 3.5		
Not really ripe		240.2 ± 3.6		
Ripe Plantain		315.6 ± 24.1		
Very Ripe Plantain		2062.0 ± 26.9		
Sweat plantain chips	GC- MS	162± 1.2-479± 1.1	Malysia	Daniali *et al.* (2010)
Sweat Plantain Chips	HPLC -DAD	24.8–1959.8	India	Shamla & Nisha (2014)
plantain chips		14.7–1690.5		
Potatoes Chips (Irish Potatoes)		82.0 to 4245.6		
Plantain Fried for 6 min	LC-MS/MS	280.00 ± 2.64	India	Mulla *et al.* (2017)
Plantain fried for 20 min	HPLC-UV	100± 4.67	Nigeria	Omotosho *et al.* (2017)
Sweet Potatoes Fries		452.0	USA	Truong *et al.* (2014)
Irish Potatoes fries (also called Potatoes Chips, French fries) 3.5 min	LC-MS/MS	10-1800	Canada	Becalski *et al.* (2004)
Irish Potatoes fries (also called Potatoes Chips, French fries) 3.5 min	HPLC-UV	1980 ±104	Eygpt	Ismial *et al.* (2013)
Irish Potatoes fries (also called Potatoes Chips, French fries)	HPLC-DAD	724	Italy	Altissimi *et al.* (2017)
Irish Potatoes fries (also called Potatoes Chips, French fries)	GC-MS/MS	294	Poland	Wyka *et al.* (2015)
Irish Potatoes fries (also called Potatoes Chips, French fries)	LC-MS/MS	300-1100	Sweden	Svensson *et al.* (2003)
Irish Potatoes fries (also called Potatoes Chips, French fries)	HPLC-UV	3267±142	Mexico	Sanchez-oter *et al.* (2017)
Irish Potatoes fries (also called Potatoes Chips, French fries)	LC-MS	227 ± 9.93	USA	Omar *et al.* (2015)
Irish Potatoes fries (also called Potatoes Chips, French fries)	HPLC-DAD	940± 35	China	Liu *et al.* (2014)
Processed Meat	LC-MS/MS and GC	2.31- 49.06	China	Chen *et al.* (2012)
Ripe Fried Plantain		9033	Nigera	Azeke & Chukwuedo (2011)
Irish Potatoes fries (also called Potatoes Chips, French fries)	LC-MS/MS	620	Saudi Arabia	Tawfik & El-Ziney (2008)
Sweet Potatoes Crips	GC-MS	213.5	Thailand	Komthong *et al.* (2012)
Meat	LC-MS/MS	2.2 - 44.0	China	Zhou *et al.* (2013)

Occurrence of acrylamide in fried food samples

Acrylamide content for sweet potato fries, Irish Potatoes fries, fried plantain, fried yam and fried meat (cow beef) were analyzed and their concentrations were between the ≤3.0 (LOD) and 733.5 µg kg^{-1}. Concentration of acrylamide found in sweet potato French fries, Irish potatoes fries, fried plantain, fried yam and fried meat were 606.67 – 720 µg kg^{-1}, 360 – 633.33 µg kg^{-1}, 460 – 500 µg kg^{-1}, ≤3.0 (LOD) – 166.7 µg kg^{-1} and ≤3.0 (LOD), respectively. Sweet potato fried for 20 min showed the highest concentration of acrylamide (720 µg/kg) while yam fried for 10 min, fried meat, used and unused oil had the lowest concentration of acrylamide ≤3.00 µg kg-1(LOD) as shown in Table 1. Percentage recovery from samples were high and values in the range of 92.66 and 99.87% were determined.

Findings of the present study on acrylamide in frying oils were similar to the findings of Pule and Torto (2012) and Totani *et al.* (2007). Pule and Torto (2012) did not find acrylamide in unused frying oil. Totani *et al*. (2007) also analysed used frying oils (maintained at 180^{o}C during deep frying) using GC/MS-SIM. Their limit of detection (0.02 mg L^{-1}) was lower than in this study but found no acrylamide. Pule and Torto (2012) used QuEChER in their method and were able to get a much lower Limit of quantification (108 ng kg^{-1}) yet they did not find acrylamide in their frying oil.

In this study, highest concentration of acrylamide was found in sweet potatoes fried for 20 min. Also in foods fried for 10 min the sweet potatoes fries had the highest concentration of acrylamide. Lower concentration of acrylamide was found in yam compare to the Irish potatoes fries for both 10 and 20 min. This may be due to the differences in their sugar contents. Sweet potatoes have more sugar than Irish potatoes and Irish potatoes has more sugar than yam. Sugar content of sweet potatoes, Irish potatoes and yam are 4.18 g 100g^{-1}, 0.89 g 100g^{-1} and 0.50 g 100g^{-1}, respectively (USDA, 2016b, USDA, 2016c). Acrylamide is a byproduct from food processing (such as in frying, baking and roasting) of carbohydrate rich foods above (120^{o}C) (Ubaoji and Orji, 2016). At elevated temperatures, asparagine (amino group) and reducing sugars naturally present in carbohydrate rich foods undergo the Maillard reaction (Golon *et al*., 2014). Plantain has higher sugar content 15 g 100g^{-1} (USDA, 2016a) compared to sweet potatoes 4.18 g 100g^{-1} but had less concentration of acrylamide. This may be because they belong to different groups of food. Plantain is a fruit while sweet potatoes is a root food so some mechanisms in these foods may be different. It may also be related to their moisture content. Plantain used in this study was hard ripe plantain and water content is known also increase acrylamide concentration (Totan *et al*., 2017). Acrylamide was not found in fried meat. This may be due to the fact that meat is a protein-rich food not

carbohydrate and does not contain reducing sugars such as glucose and fructose. But this result was in contrast to the report of Chen *et al*. (2012) where the range of acrylamide in processed and cooked meats was between 49.06 and 78.57 ug kg^{-1}, respectively.

Foods fried in the heated oil for 20 min in this study had more acrylamide than those fried for 10 min in the heated oil as shown in Table 1. Similar trends were observed with other studies. Matthäus *et al.* (2004) found a linear relationship between lengths of frying minute to the concentration of acrylamide in fried potatoes. Mulla *et al*. (2017) also observed an increase in acrylamide content as length of frying time increased.

Result of acrylamide in Irish potatoes fries and fried plantain are in the same range of values from other studies as seen in Table 2 for fried plantain, French fries, fried meat, fried yam and fried sweet potatoes. However, there was no study on acrylamide in fried yam.

Risk assessment of acrylamide in samples

Comparison with EU benchmark value for acrylamide

In Europe, bench mark values for foods usually found with acrylamides was set and a value of 500 µg kg^{-1} has been set for French fries to be enforced from 2018 (EU, 2017). No bench mark value was set for other fried food in this study thus the bench mark for acrylamide in fried food were also used to compare with other fries in this study. The acrylamide concentration in sweet potatoes fries exceeded the bench mark value at both 10 and 20 min of frying; while for French fries, the acrylamide concentration less than the benchmark value when fired for 10 min and higher than the benchmark when fried for 20 min (Table 1). Acrylamide levels in fried plantain, yam and meat were all below the bench mark value.

Result of risk assessment from the EDI approach

Risk assessment of acrylamide concentration in the fried food samples were also determined using the EDI approach as earlier explained and the result is as shown in Table 3. EDI values for adult were 0.66, 0.88, 0.11, 0.64 and 0.01 µg kg^{-1} body weight day^{-1} for French fries, Sweet potatoes fries, fried yam, fried plantain and fried meat, respectively. For children the EDI values were between 3.18 and 0.01 µg kg^{-1} body weight day^{-1}. Children as a result of their smaller body size compared with adult were found to have higher EDI values which indicates more risk. The findings in this study were similar to those in other study. Tawfik and El-Ziney (2008) in a similar study referred to children as a risk group. For children between ages 6 and 11 years the Canadian government found their average exposure to acrylamide from different foods were about two times that of adult exposure (GOC, 2012). The EDI of adults for banana and plantain based snacks was found to be in the range of 0.01 to 1.2 µg kg^{-1} body weight day^{-1} in Daniali *et al*. (2010) similar to the EDIs in this study. EDI value of 0.001 to 0.076 µg kg^{-1} body weight day^{-1} for exposure to acrylamide from potatoes was also determined in a study by Zhou *et al*. (2013). An EDI value of 4 µg kg^{-1} body weight day^{-1} is said to be high while a value of 200 µg kg^{-1} body weight day^{-1} causes Morphological nerves of in rats are observed (WHO, 2011). EDI values in this study were all lower than 4 and 200 at 200 µg kg^{-1} body weight day^{-1}.

Table 3: EDI for adult and children of some fried Nigerian foods

Samples	EDI Adult (µg kg^{-1} body weight day^{-1})	EDI Children (µg kg^{-1} body weight day^{-1})
French fries	0.66	2.38
Sweet potato fries	0.88	3.18
Fried Yam	0.11	0.40
fried Plantain	0.64	2.03
Fried meat	0.01	0.02

Since children are the risk group, they should be encouraged to eat more non fried starchy food compared to fried starchy foods which are prone to having acrylamide a potential carcinogen.

Conclusion

Despite the prevalence of literature on acrylamide studies in foods, there is no information on acrylamide in fried yam. These studies have been limited to certain foods (especially French fries). This study has provided information about acrylamide in other fried foods. An improved HPLC-UV method for analysis of acrylamide in some commonly consumed fried food was developed by using lamivudine as internal standard and adjusting the pH of mobile phase. The risk associated with the concentration of acrylamide determined was also assessed by the bench mark and EDI approach. The acrylamide concentration in sweet potatoes fries exceeded the bench mark value. While the acrylamide concentration in French fries was less than the benchmark value when fired for 10 min but higher than the benchmark value when fried for 20 min. Acrylamide levels in fried plantain, yam and meat were all below the bench mark value. Children were found to be more exposed to acrylamide risk than adults base on the EDI. Though EDI values in this study were below 4 µg kg^{-1} body weight day^{-1} (value for high exposure) and at 200 µg kg^{-1} body weight day^{-1} (value above which morphological changes in nerves of rats are observed), children should be encouraged to eat more non fried starchy food compared to fried starchy foods which are prone to having acrylamide a potential carcinogen since they are the risk group. This study has therefore provides information on the presence of acrylamide some commonly eaten fried foods.

Conflict of Interest

The authors declare that there is no conflict of interest related to this study.

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