International Journal of Science and Advanced Innovative Research
ISSN: 2536-7315 (Print) 2536-7323 (Online)
Volume 4, Number 4, December, 2019
http://www.casirmediapublishing.com

Comparative Study on the risk Assessment of Polycyclic Aromatic Hydrocarbons (PAHs) Content in the Roasted muscle of Free-lance and Broilers Chicken in Akwa Ibom State Nigeria

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ABSTRACT

Comparative study on the risk assessment of polycyclic aromatic hydrocarbons (PAHs) content in the roasted muscle of free-lance and broilers chicken in Akwa Ibom State Nigeria were carried out using standard analytical methods as described by USEPA,2010. The result obtained for the Risk Assessment of PAHs content in the roasted muscle of freelance were; anthracene; 0.0670mg/kg, Pyrene; 0.5383mg/kg, Benzo(a) Anthracene; 4.1784mg/kg, Chrysene; 0.2188mg/kg, Benzo(k) fluranthene; 0.1443mg/kg, Benzo(a) Pyrene; 0.0478mg/kg, Benzo (g,h,i) Pyrene; 0.6318mg/kg, Diabenz(a,h) anthracene; 0.5664mg/kg and Indeno(1,2,3-cd) Pyrene; 0.9990mg/kg. The result for roasted muscle of the broilers chicken were; anthracene; 0.0509mg/kg, Pyrene; 0.0007mg/kg, Benz(a) anthracene; 0.0032mg/kg, Chrysene; 0.0309mg/kg, Benzo(k) flouranthene; 0.0018mg/kg, Benzo(a) Pyrene; 0.0609mg/kg, Benzo(g,h,i) Pyrene; 0.0483mg/kg, Dibenz(a,h) anthracene; 0.0794mg/kg and indeno(1,2,3-cd) Pyrene; 0.0039mg/kg. The concentration of Pyrene, benz(a), anthracene, benzo(g,h,i) Pyrene, Dibenzo(a,b) anthracene and indeno(1,2,3-cd)Pyrene were higher in roasted freelance chicken than the European Union Standard Limit. The correlation analysis shows a positive strong correlation at $P<0.01$ as follows : Anthr/Py (r = 0.950546), Anthr/Chry (r = 0.79307), Py/Chry (r = 0.943036), B(a)A/Chry (r = 0.87532), Anthr/B(f)F (r =0.82591), Py/B(f)F (r=0.960178), Chry/B(f)F (r =0.998433), Py/B(g,h,i)P (r=0.810799), Chry/B(g,h,i)P (r = 0.959345), B(f)F/B(g,h,i)P (r=0.942045), Anthr/D(a,h)A (r=0.819004), Py/D(a,h)A (r =0.956711), While there was a negative correlation between Anthra/B(A)P(-0.73645) at $P<0.01$. This correlation shows that as the potential risk of anthracene increases, the potential risk of B(a)P decreases. The research shows that there is risk in consumption of roasted muscle of freelance chicken than roasted muscle of broilers chicken.

Key words; Risk assessment, Trace metals and Roasted chicken

INTRODUCTION

Chicken is being cooked in many different ways either ordinarily or combined with other foods such as grains, vegetables or fruits. According to Marques et al., (2011), the presence of polycyclic aromatic hydrocarbon (PAHs) in the cooked meat is greatly depending on the cooking method in which smoking as an oldest technology for the conservation of meat generates phenolic substances which have considerable importance in organoleptic properties of a smoked meat. Besides that, phenolic compound show antimicrobial and antioxidant properties. Smoking technology nowadays uses specific effects of various sensory active compounds contained in smoke, aromatization of meat products with suitable organoleptic profile which increase the demand in the market (Lorenzo et al., 2011). Polycyclic aromatic hydrocarbon (PAHs) as undesirable consequence of smoking are generated during incomplete combustion of wood, comprising of large group of organic compounds with two or more fused aromatic ring and represent a class of organic pollutants that are carcinogenic, teratogenic, and mutagenic (Conde et al., 2005; Janoszka et al., 2004). The risk of exposure to PAHs depends on the type of diet, eating habits, cooking and smoking practices, which often are linked to regional traditions (Reinik et al., 2007). The composition and concentration of PAHs contaminating smoked meat products depends on multiple factors such as type of wood, its moisture content, as well as temperature achieved during smoke generation (Garcia – falcon and Simal – Gandara, 2005).

As PAHs represent an important class of carcinogens, their presence and amount in food has been intensively studied. Some PAHs are identified as mutagenic and carcinogens in mammalian cells. PAHs undergo metabolic activation to diol epoxides that bind covalently to cellular macromolecules, such as DNA, leading to errors in DNA replication and mutations that can initiate carcinogenesis (Badry, 2010). Studies have shown that most food intake of PAHs comes from vegetables and cooked meat. Exposure includes breathing of PAHs in tobacco smoke, auto-emissions or industrial exhausts, consumption of charcoal boiled food and contaminated water. Human exposure to PAHs is over 90% linked to food and it penetrate via water and air (Garcia – Falcon et al., 2004). They can also be absorbed through the lungs, breast, oropharynx and gastrointestinal tracts. Several animal and human studies have implicated colon cancer and other forms of cancer dietary exposure to PAHs (Giovasnnucci et al., 1994).

MATERIALS AND METHODS

The muscle of roasted free-lance chicken was obtained and dried to a constant weight in an oven at 60°C and allow to cool in a desiccator. The cooled samples were pulverized using a ball grinder, further sifted through a 0.5mm mesh to a fine particle size for exhaustive extraction. 10g was weighed for each sample, mixed with 10g of anhydrous sodium sulphate (Na_2SO_4). The blended sample was transferred into a soxhlet extractor thimble. Approximately, 200ml of the extraction solvent (methylene chloride) was measured into a 500ml round bottom flask containing two clean boiling chips. The flask was attached to the extractor and the sample was extracted for 6hours at 4-6 cycles/hours. The extract was allowed to cool after the extraction was complete (USEPA, 2010). The methylene chloride extract was made to dry up on a water bath set at 50°C and exchanged with 4ml cyclohexane for clean up using column chromatographic technique and finally reconstituted in 1ml n-hexane for GC-MS analysis. This same process was done using the muscle of broiler's chicken.

Determination of Carcinogenic Risk

Carcinogenic risk (CR) values of polycyclic aromatic hydrocarbon in the muscles of chicken were predicted from their chronic daily intake (CDI) obtained from the equation predicted by (Caylak, 2012 and USEPA, 1992)

$$CR = CDI \times SF$$

Where, CR = Cancer Risk; SF = Slope factor; CDI = chronic daily intake ingestion pathway.

Slope factor for individual carcinogenic PAHs were used (Srogi, 2007)

Chronic daily intake via ingestion was calculated using the equation below:

$$CDI = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

Where, CDI is the chronic daily intake via ingestion (mg/kg/day), C is the concentration of PAHs in mg/kg, IR is the intake rate (2kg per day for adults and 0.61kg for children).

BW is the body weight of the exposed person (70kg for normal adult and 30kg for children), EF is the exposure frequency (365 days/year), ED is the exposure duration over a life time (70 years for adults and 10 years for children), AT is the averaging time in days (70 years x 365 days)/year) for adult and 365 days for children.

RESULT AND DISCUSSION

Figure 1 - Concentration of PAHs in the roasted muscle of free-lance and broilers chickens.

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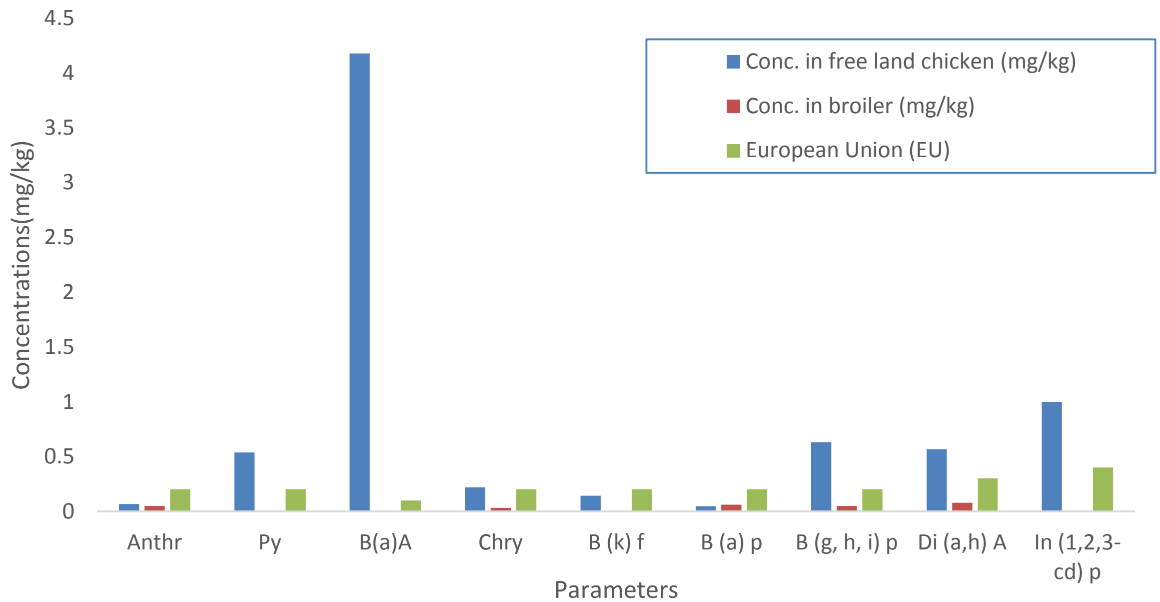
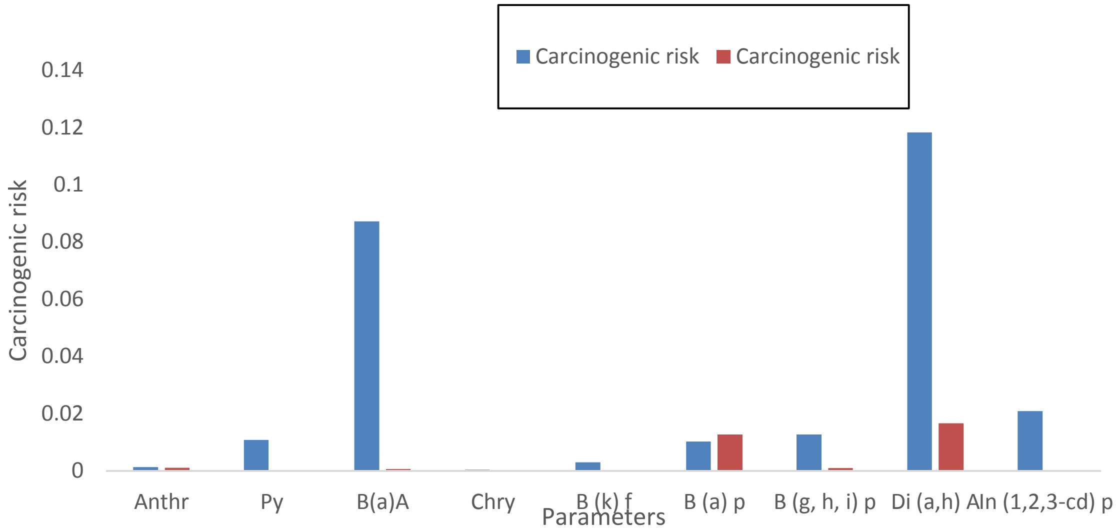


key: Anthracene - Anthr , Pyrene- Py, Benz (a) anthrance- B(a)A, Chrysene - Chry, Benzo (k) floranthene - B (k) f, Benzo (a) pyrene - B (a) p, Benzo (g, h, i) pyrene - B (g, h, i) p, Dibenz (a,h) anthracene - Di (a,h) A, Indeno (1,2,3-cd) pyrene - In (1,2,3-cd) p.

The analysis of PAHs in the muscle of free-lance and broiler chicken revealed that, the accumulation of PAHs in the muscles of chickens differs. The results of anthracene shows 0.0670 mg/kg for free-lance and 0.0509mg/kg for broiler's chicken which were all within the EU permissible limit of 2.0mg/kg. Pyrene shows a high value of 0.5383mg/kg for free-lance chicken but the 0.0007mg/kg for broilers chicken. The high value in free-lance chicken may be attributed to the present of sand in the meal consumed by the chicken. Though both results were within EU permissible limit.
Benz (a) anthracene recorded a high value of 4.1784mg/kg for free-lance chicken which is highly above the EU permissible limit. The high value may be attributed to polluted water consumed by those free-lance chickens. Chrysene, Benzo (k) and Benzo (a) Phyrene revealed 0.2188 mg/kg, 0.1443 mg/kg and 0.0478mg/kg for free-lance chicken which were in accordance with the EU permissible limit. The broiler chicken revealed 0.0309 mg/kg for chrysene, 0.0018mg/kg for Benzo (k) flouranthane and 0.0609mg/l for Benzo (a) pyrene. These are regarded as the most potents PAHs. It metabolism in living system increases its toxicity (Cavalieri and Rogan, 2017). As the living system attempts to degrade Benzo (a) pyrene, it forms reactive metabolites that may bind with DNA causing disruption to the paretic functioning of the affected cell inducing a genotoxic effect (Wogan *et al.*, 2004).

Benzo (h,g,i) pyrene and Dibenz (a,h) anthracene in the muscle of free-lance chicken was found to be 0.63181mg/kg and 0.5664mg/kg while broiler's chicken was found to be 0.0483mg/kg and 0.0794mg/kg respectively. This was slightly higher than the Ujowundu *et al*, (2014) who had 0.003032 mg/kg and 0.000346mg/kg. This may be attributed to the level of pollution in the different areas that the chickens were raised, although all results were within Eu permissible limit. Indeno (1, 2, 3) pyrene was found to be 0.9992mg/kg for free-lance and 0.0039mg/kg for broiler's chicken. The high value from free-lance may be cause by the polluted water and feed consumed by those chickens.

Figure 2- Carcinogenic Risk Assessment



Carcinogenic risk assessment (CR) is the incremental probability of an individual developing any type of cancer over a lifetime a result of exposure to a potential carcinogen (Caylak, 2012).
The computation revealed the carcinogenic risk induced by path through ingestion of free-lance and broiler's chicken. The carcinogenic risk of free-lance chicken ranged from 0.11826 to 0.00045 with Dibenz (a,h) anthrance recording the highest value and chrysene recording the lowest value. The carcinogenic risk assessment of broiler's chicken revealed risk value ranging from 0.016571 to 0.00001 with Dibenz (a,h) anthrance recording the highest value and pyrene recording the lowest value. When the carcinogenic risk of free-lance and broiler's chicken was compared, Dibenz (a,h) anthrance recorded the highest values in both free-lance and broiler. This carcinogenic risk value indicates potential risk associated with the consumption of chicken (free-lance) from the studied area.

Correlation analysis of the Concentration of PAHs in the roasted muscle of free-lance and broilers chickens

**	Anthr	Py	B(a)A	Chry	B(f)F	B(a)P	B(g,h,i)P	D(a,h)A	In(1,2,3-cd)P
Anthr	1								
Py	0.950546**	1							
B(a)A	0.399649	0.664588*	1						
Chry	0.79307**	0.943036**	0.87532**	1					
B(f)F	0.82591**	0.960178**	0.846886**	0.998433**	1				
B(a)P	-0.73645**	-0.48992	0.325793	-0.17199	-0.22685	1			
B(g,h,i)P	0.588908*	0.810799**	0.976208**	0.959345**	0.942045**	0.113035	1		
D(a,h)A	0.819004**	0.956711**	0.853287**	0.999039**	0.999926**	-0.215	0.946054**	1	
In(1,2,3-cd)P	0.60063*	0.819248**	0.972942**	0.963358**	0.946837**	0.098535	0.999894**	0.950678**	1

Correlation is significant at the 0.01 level (2 tailed)

* Correlation is significant at the 0.05 level (2 tailed)

The results of the correlation analysis calculated among individual polycyclic aromatic hydrocarbons (PAHs) in the muscles of chicken to assess their relationship is shown in the table above. The following polycyclic aromatic hydrocarbons (PAHs) showed strong positive correlation as follows; Anthr/Py (r = 0.950546), Anthr/Chry (r = 0.79307), Py/Chry (r = 0.943036), B(a)A/Chry (r = 0.87532), Anthr/B(f)F (r =0.82591), Py/B(f)F (r=0.960178), Chry/B(f)F (r =0.998433), Py/B(g,h,i)P (r=0.810799), Chry/B(g,h,i)P (r = 0.959345), B(f)F/B(g,h,i)P (r=0.942045), Anthr/D(a,h)A (r=0.819004), Py/D(a,h)A (r =0.956711), Chry/D(a,h)A (r = 0.999039), B(f)F/D(a,h)A (r = 0.999926), B(g,h,i)P/D(a,h)A (r = 0.946054), Py/In(1,2,3)P (r = 0.819248), B(a)A/In(1,2,3)P (r =0.972942), Chry/In(1,2,3)P (r = 0.963358), B(f)F/In(1,2,3)P (r = 0.946837), B(g,h,i)P/In(1,2,3)P (r =0.999894), D(a,h)A/In(1,2,3)P (r = 0.950678) while there was also a negative correlation between Anthr/B(a)P(-0.73645) all correlated at $P<0.01$, the negative correlation between Anthr and B(a)P shows that, as the potential risk of Anthr increases, the potential risk of B(a)P decreases. The correlation also revealed a positive correlation at $P<0.05$ of polycyclic aromatic hydrocarbons (PAHs) between Py/B(a)A (r = 0.664588), Anthr/B(g,h,i)P (r = 0.588908), as well as Anthr/In(1,2,3)P (r = 0.60063) correlated at $P<0.05$.

CONCLUSION

This research work conducted to compare the risk associated with the consumption of roasted free-lance and broiler's chicken from the studied area revealed high cumulative risks of PAHs associated with the ingestion of free-lance than broiler's chicken. Hence, there is an urgent need to initiate suitable processing methods to reduce the risk associated with consumption of roasted free-lance chicken. On accumulation PAHs can cause cancer, cardiovascular disease as well as fetal poor development or even death.

ACKNOWLEDGEMENTS

We wish to thank Tertiary Education Trust Fund, Nigeria (TETFUND) for the financial support to this research.

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