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PREVALENCE OF POLYCYCLIC AROMATIC HYDROCARBONS IN FRESH MEAT TYPES AT GUSAU CENTRAL ABBATOIR, ZAMFARA STATE, NIGERIA

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ABSTRACT

Ingestion of Polycyclic Aromatic Hydrocarbons (PAH) in food can cause cancer not only through the mutagenic properties of their metabolites, but also through their parent compounds which potentially enhance tumor initiation and progression. World Health agencies mentioned PAHs in priority pollutant list owing to their carcinogenic and mutagenic properties. This research was conducted between the months of April to August 2023 in Gusau Central Abattoir Zamfara State, to determine the type and prevalence of PAH in fresh beef, chevon and mutton. The samples were collected in two visits with a total of 36 samples collected and analyzed using Gas Chromatography Mass Spectroscopy (GC-MS) technique. Results indicated a total of 45 PAHs belonging to 16 types of PAH compounds were detected in both rainy and dry season among the three meat types. Seventeen PAH compounds were detected in fresh beef samples, 13 PAH occurred in chevon 15 were detected in mutton samples. The PAH 1,2,3,4-tetrahydro Naphthalene was found to be more prevalent (37.77%), followed by Decahydro-1-Naphthalene with (8.88%) and Decahydro-2-met-Naphthalene, Naphthalene, 2-methyl-Naphthalene, were identified with prevalent of about 6.66% each. Similarly, Decahydro-Naphthalene, 2,3,6-trimethyl-Naphthalene, 1,6-dimethyl-4-(1)-Naphthalene and 1,5-dimethyl-Naphthalene were found with 4.44% each. However, the less occurring PHA were Anthracene, Phenanthrene, 1,2-dimethyl-Naphthalene, 2,6-dimethyl-Naphthalene, 1-methyl-Naphthalene, 1,8-dimethyl Naphthalene and Azulene at 2.23% each. It was therefore concluded the presence of some PAH in fresh meat pose safety risks to consumers owing to their toxicity and their possible bioaccumulation.

Keywords: Polycyclic Aromatic Hydrocarbons, prevalence, beef, chevon, mutton

Introduction

Meat refers to animals' flesh (skeletal muscles) and other parts such as fats, liver kidney, heart, lung, brain, intestine, and connective tissue that serve as food (Olayinka and Sani, 2014). Worldwide, including in Africa and Nigeria, meat is considered a rich source of protein and essential micronutrients that are needed for growth and good health for people in various socio-demographic categories, including the young, old, rich and poor (Olayinka and Sani, 2014). The majority of the Nigerian populace depends on livestock for food and livelihood (Elelu, *et al.*, 2019). Meat requires adequate preservation due to its short shelf life (Olaoye, *et al.*, 2016). On the other hand, meat has essential nutrients that support microbial growth and metabolism when adequate preservation and hygiene is not maintained (May *et al.*, 2003; Eke *et al.*, 2013; Nwakanma, *et al.*, 2015).

Polycyclic aromatic hydrocarbons (PAHs) are a group of environmental contaminants that come from the incomplete combustion of organic matter which over the years have drawn much scrutiny due to their ability to cause cancer (Akpambang *et al.*, 2009). When ingested, unmetabolized Polycyclic Aromatic Hydrocarbons (PAHs) can have toxic effects, but the ability of its reactive metabolites such as epoxies and dihydrodiols to bind to cellular proteins and DNA with its resultant biochemical disruptions and cell damage leading to mutations, developmental Malformations, tumors and cancer is of major concern (Nisha *et al.*, 2015). Generally contamination of meat depends on the nature and age of the animal, place of animal rearing, dietary habits, slaughtering, transportation

condition and exposure time (Sabir *et al.*, 2003). Polycyclic aromatic hydrocarbons are produced as a result of incomplete combustion and pyrolysis processes from anthropogenic and natural sources of carbonaceous materials such as wood and coal. Food processing such as roasting, grilling, smoking, and drying also significantly contribute to the source of PAHs in food substances (Plaza-Bolanos .2010). Studies have shown that ashes produced from firewood as a result of the smoking and roasting of food contain an appreciable amount of PAHs Onwukeme (2015). Some PAHs are identified to demonstrate both cancers causing and mutagenic characteristics. Nevertheless, PAHs that do not exhibit carcinogenic properties, synergistically promote the carcinogenic properties of different PAHs. Benzo[a] pyrene is carcinogenic and it has been used by many authors as a proxy to understand the influence of diet on the consumption of polycyclic aromatic carcinogens (Ramesh *et al.* 2018. Alomirah *et al.* (2011), discovered that the human dietary exposure to Benzo[a]pyrene was 2-500 ng/day which is above exposure through inhalation of 10-50 mg/day. PAHs can cause cancer not only through the mutagenic properties of their metabolites, which can initiate tumor formation by modifying DNA, but also through their parent compounds, which enhance tumor progression (USEPA, 2017). A particular PAH like naphthalene when inhaled or ingested in high concentration can result in the breakdown of red blood cells. Anthracene and Benzo[a]pyrene have also been discovered to affect the skin, that is, bring about an allergic reaction in the skin of animals and humans (IPCS 2010). Apart from PAHs contaminations, heavy metal contamination

may arise from the materials used in sausage rolls baking. Studies by authors in various locations in Nigeria have revealed that heavy metals, polycyclic hydrocarbons (PAHs) and microorganisms are major sources of contaminants on fresh meat, and this is of public health significance in initiating reductions of food borne diseases (Nwakanma *et al.*, 2015; Folorunso *et al.*, 2018). To this end, this research work will attempt to provide an update on the Evaluate the prevalence of Polycyclic Aromatic Hydrocarbons (PAHs) among Beef, Chevron and Mutton in Gusau local Government Area, Zamfara State.

Materials and Methods

Study Area

This research was conducted between the months of April 2023 and August 2023 in Gusau Central Abattoir Zamfara State. The city of Gusau, locate in northwestern Nigeria. Gusau is the capital city of Zamfara State. It is also the name of the state's Local Government Area (LGA), which has an area of 3,364 km (2,090 mi)² and a population of 383,162 as of the 2006 census.

Treatments and Experimental Design

The study consists of Three (3) treatments involving Three (3) types of meat (beef, mutton and chevon). Each of the meat types represents a treatment. The treatments were replicated two (2) times in a Completely Randomized Design (CRD).

Sampling and Sample Size

The samples being used for the study were obtained from Gusau central abattoir. The samples were collected in two (2) times visit,

rainy and dry season. In each visit, six (6) fresh meat samples were collected each from beef, mutton and chevon making Six (18) samples in every visit. A total of 36 samples were collected. For every collection, the fresh meat samples were taken to the Biotechnology Laboratory for the determination of polycyclic aromatic hydrocarbons.

Determination of Polycyclic Aromatic Hydrocarbons

The polycyclic aromatic hydrocarbon content of the samples was determined using gas chromatography (GC-MS Spectrometer model 6800) according to the method described by TNRCC (2015). The method is based on a saponification and liquid extraction step, followed by solid phase extraction (SPE) cleanup of the extract and finally, the determination of PAHs using high performance gass chromatography mass spectroscopy, with fluorescence detector. Four hundred (400) mg of lyophilized sample was weighed in a teflon lined vessel (Green Chem plus, CEM Corporation), added with 1.6 mL of water, 8 mL of saturated methanolic potassium hydroxide and 20 mL of n-hexane. Microwave assisted saponification/extraction were carried out at 120 °C for 20 min. Once cooled, vessels were opened and a measured amount (15 mL) of the organic extract, corresponding (with a relative uncertainty of less than 2%) to 3/4th of the added amount of hexane, was withdrawn with a volumetric pipette and concentrated to a few microliters using a rotavapor and then a nitrogen flow. In order to minimize volatile PAH losses (which resulted higher when the last portion of solvent was evaporated to dryness under nitrogen flow or under vacuum),

the residual solvent were allowed to evaporate spontaneously to dryness at room temperature, and the residue were then be dissolved with 400 μL of n-hexane. Sample purification will be performed by solid phase extraction (SPE). To speed up sample preparation reducing sample manipulation (avoiding the necessity to wash the test tube with additional solvent in order to realize a quantitative transfer of the sample extract onto the cartridge), a measured part of the sample extract (200 μL) was directly loaded on a 500 mg silica cartridge (Supelco), previously conditioned with 2 ml of dichloromethane and 2 ml of n-hexane. After sample loading, the PAH fraction was eluted with 3 ml of nhexane/dichloromethane (70/30). The fraction so obtained was gently concentrated to a few microlitres under a nitrogen flow and then left to evaporate spontaneously to dryness at room temperature. The sample residue was dissolved in 100 μL of acetonitrile and directly injected into the HPLC apparatus. Two different aliquots of each sample underwent the entire analytical procedure (two replicates) and each replicate was injected twice. Analytical blanks (prepared in duplicate by subjecting all reagents and solvents, except the sample, to the entire procedure) were analyzed (in duplicate) every day together with the samples and average data obtained were subtracted to those obtained from the real sample.

Data Analysis

The PAHs data collected on prevalence in the three (3) meat type samples were subjected to descriptive statistics and expressed in percentages.

Results and Discussion

Prevalence of PAHs Detected in Beef, Chevron and Mutton Samples in Dry and Rainy Seasons at Gusau Central Abattoir

Results on prevalence of PAHs detected in beef, chevon and mutton in dry and rainy season in Gusau Central Abattoir Zamfara State are presented in Table 4.1. Results indicated a total of (45) PAHs belonging to 16 types of PAHs were detected in both rainy and dry seasons in all the types of meat. Therefore (17) of the compounds were found in raw beef meat samples. While (13) compounds were detected in chevon raw meat samples and (15) compound were detected in mutton raw meat samples. Among the PAHs detected, 1,2,3,4-tetrahydro Naphthalene was found to be more prevalent (37.77%) identified for both rainy and dry season samples and was more prevalent in Mutton (detected 11 out of 12 samples). Decahydro-1-Naphthalene had 8.88% and was only detected in beef samples (3). Also, Decahydro-2-met Naphthalene, Naphthalene, 2-methyl-Naphthalene, were identified with prevalence of about 6.66% each, then it was followed by Decahydro-Naphthalene, 2,3,6-trimethyl-Naphthalene, 1,6-dimethyl-4-(1) Naphthalene and 1,5-dimethyl-Naphthalene with 2.44% each. However, the less occurring PAHs includes Anthracene, Phenanthrene, 1,2-dimethyl-Naphthalene, 2,6-dimethyl-Naphthalene, 1-methyl-Naphthalene, 1,8-dimethyl Naphthalene and Azulene were found with prevalence of 2.23% each from the samples collected in the study area. Among the types of PAHs detected in both beef chevon and mutton raw meat samples in dry and rainy season, only Phenanthrene and Anthracene were classified

among the carcinogenic compounds by NIOSH (2019).

Table 4.1 Prevalence of PAHs Detected in Beef, Chevon and Mutton samples in Dry and Rainy Seasons in Gusau Central Abattoir

Type of PAHs detected	Type of meat			Frequency (%)
	Beef	Chevon	Mutton	
Decahydro-2-met Naphthalene	3	0	0	3(6.66)
Decahydro- Naphthalene	2	0	0	2(4.44)
1,2,3,4-tetrahydro Naphthalene	4	2	11	17(37.77)
2,3,6-trimethyl- Naphthalene	2	0	0	2(4.44)
1,6-dimethyl-4-(1) Naphthalene	2	0	0	2(4.44)
Anthracene	1	0	0	1(2.23)
1,5-dimethyl- Naphthalene	1	1	0	2(4.44)
Phenanthrene	1	0	0	1(2.23)
1,2-dimethyl- Naphthalene	1	0	0	1(2.23)
Decahydro-1 Naphthalene	0	4	0	4(8.88)
2,6-dimethylNaphthalene	0	1	0	1(2.23)
1-methyl- Naphthalene	0	1	0	1(2.23)
1,8-dimethyl Naphthalene	0	1	0	1(2.23)
Naphthalene	0	1	2	3(6.66)
2-methyl- Naphthalene,	0	1	2	3(6.66)
Azulene	0	1	0	1(2.23)
Total 16	17	13	15	45(100)

The effect of naphthalene exposure can be harmful to human health. Inhalation or ingestion of naphthalene can cause symptoms such as headache, nausea, vomiting, diarrhea, confusion, and in severe cases, liver and kidney damage. (CDCP, 2020). Chronic exposure to naphthalene has been linked to an increased risk of developing cancer, 1,5-dimethyl-naphthalene is a chemical compound with two methyl groups attached to specific positions on a naphthalene ring. Chemical Safety Data Sheet for Naphthalene. (NIOSH, 2019). The presence of methyl groups at the 1 and 5 positions of the naphthalene ring affects its chemical stability and reactivity compared to unsubstituted

naphthalene. The rate and extent of naphthalene absorption in humans exposed by inhalation have not been determined, but there is evidence for uptake via inhalation from case reports and occupational health studies. Clinical reports suggest that prolonged exposure to naphthalene vapors can cause adverse health effects in humans Harden *et al*, (2018). In addition, naphthalene has been detected in the expired air of workers exposed to naphthalene-containing jet fuels, and naphthalene metabolites have also been detected in the urine of such workers (Egeghy *et al*, (2016).

The compound 2-methyl naphthalene is toxic and potentially carcinogenic. It can also

contribute to environmental pollution, particularly in areas where there is incomplete combustion of fossil fuels (EPA, 2021). Its specific effects can vary depending on the context of its application, such as in chemical reactions, pharmaceutical research, or material science. (National Library of Medicine (NLM, 2016).

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