Innovative: International Multi-disciplinary Journal of Applied Technology
(ISSN 2995-486X) VOLUME 02 ISSUE 04, 2024

Determination of Polycyclic Aromatic Hydrocarbons Concentration in Chicken Meat

Haneen Abd Al-RazzaqMuhammad
Department of chemistry, College of Science, Baghdad University

Zainab Abd al_Hassan Khadem
Department of chemistry, College of Science, University of Babylon

Marwah Jassim Mohammed
Department of chemistry, College of Science, Baghdad University

Abstract:

The presence of polycyclic aromatic hydrocarbons (PAHs) was studied in the different cooking methods of chicken. The levels of 16 PAHs compound were determined in raw and cooked chicken meats. The chicken was cooked with different methods, i.e. boiling, frying, barbequing and roasting. The uncooked sample served as the reference. With the aid of the 16 PAHs reference standards, the levels of the PAHs were determined using gas chromatography flame ionization detector (GC-FID) after extracting with methylene chloride by soxhlet extraction. The obtained data showed the total PAHs as 0.0521,01408, 10.8374, 0.2008 and 0.1817 and total carcinogenic PAHs as 0.0516, 0.0933, 7.4868, 0.1343 and 0.0.3610 µg/kg in the control, boiled, fried, barbecued and roasted chicken samples respectively.

Keywords: *determination, polycyclic aromatic hydrocarbons, concentration.*

Introduction

Polycyclic aromatic hydrocarbons (PAHs) constitute a large class of organic compounds. PAHs consist of hydrogen and carbon arranged in the form of two or more fused benzene rings. There are thousands of PAH compounds, each differing in the number and position of aromatic rings, and in the position of substituents on the basic ring system. Environmental concern has focused on PAHs that range in molecular weight from 128.16 (naphthalene, 2-ring structure) to

300.36 (coronene, 7-ring structure). Unsubstituted lower molecular weight PAH compounds, containing 2 or 3 rings, exhibit significant acute toxicity and other adverse effects to some organisms. The U.S. Environmental Protection Agency (EPA) lists sixteen as "Consent Decree" priority pollutants. smokers the major route of exposure is consumption of food, for smokers the contribution from smoking may be significant. Food can be contaminated from environmental sources, industrial food processing and from certain home cooking practices {1,2}.

Environmental pollutants originating from a wide variety of natural and anthropogenic sources for Polycyclic aromatic hydrocarbons (PAHs) {3- 5}. Due to the carcinogenic nature of some PAHs, their chemical analysis is of great environmental and toxicological importance. A plethora of different PAHs may be formed and released during a variety of combustion and pyrolysis processes. Thus the natural and anthropogenic sources of PAHs in the environment are numerous. So far about 500 PAHs have been detected in ambient air. The emission of PAHs during industrial production and processing in developed countries are not thought to be important in comparison with the release of PAHs from incomplete combustion processes, since closed systems and recycling processes are usually used {6}.The primary natural sources of airborne PAHs are forest fires and volcanoes. The most important stationary anthropogenic sources include residential burning of wood, oil, gas and charcoal as well as industrial power generation, incineration, production of aluminium, iron and steel, petroleum catalytic cracking and production of asphalt, coal tar and coke {7}.Stationary sources account for approximately 80% of total annual PAH emissions. The most important mobile sources are vehicular exhausts from gasoline and diesel-powered engines {8-12}.In combustion processes the formation of PAHs is reduced when combustion is more thoroughly performed but this will increase the formation of nitrogen oxides {9}.In the past decade PAHs were evaluated by the International Programme on Chemical Safety (IPCS), the Scientific Committee on Food (SCF) and by the Joint FAO/WHO Expert Committee on Food Additives (JECFA). SCF concluded that 15 PAHs, namely benz[a]anthracene, benzo[b]fluoranthene, benzo[/]fluoranthene, benzo[k] fluoranthene, benzo[ghi]perylene, benzo[a]pyrene, chrysene, cyclopenta [cd]pyrene, dibenz[a,h]anthracene, dibenzo[a,e]pyrene, dibenzo[a,h] pyrene, dibenzo[a, i]pyrene, dibenzo[a]pyrene, indeno [1,2,3-cd]pyrene and 5- methylchrysene show clear evidence of mutagenicity/ genotoxicity in somatic cells in experimental animals in vivo and with the exception of benzo[ghi]perylene have also shown clear carcinogenic effects in various types of bioassays in experimental animals. Thus, SCF reasoned that these compounds may be regarded as potentially genotoxic and carcinogenic to humans and therefore represent a priority group in the assessment of the risk of long-term adverse health effects following dietary intake of PAHs {13-15}.

Methodology

Sampling and Preparation

The fattened broiler chickens used in this study were obtained from a local market at Eke Awka, Anamera, State, Nigeria. The cooking condiments avitch comprised of galli cloves, ginger, curry powder, thyme, common salt (sodium chloride) and seasoning cubes were also live portions, four of which were inter mixed together, seasoned and douca aneczowak, the fom poladsanilung anziariogkarne wache established. One portion was tried, one was roasted, one was barbecued and the last portion was left without further treatment. All five portions of Levitiken batman Suparatry

oficeria constant weigin th in greirai established-One portion was fried, one was roasted, one was barbecued the chicken meat were separateiv dried to a constant weight in the oven at

AHs Extraction PAHS

clean boiling chips. The flask was attached to the extractor and the sample was extracted for 6 hours. The extract was allowed to cool after the extraction was complete {11}. The collected solution was further concentrated to dryness and finally reconstituted in 1 mL n-hexane for GC/FID analysis

Stock Standard Solutions.

prepared at a concentration of A stock standard solution previously prepared 1.00ug/uL by dissolving 0.0100 g of assayed reference material in n- hexane and diluting to volume in a 10-mL volumetric flask. The stock

standard solution was transferred into Teflon-sealed screw cap bottle. Store at 4°C and protected from light.

Sample Analysis

Calibration standards: Calibration standards of five concentration levels (0.1, 0.5, 1.0, 1.5 and 2.0 µg/ml) were prepared through dilution of the stock standards(1000µg/mL)with n-hexane.

Results and Discussions

3.1 The levels of 16 Polycyclic Aromatic Hydrocarbons (PAHs) compounds

The data revealed that the control contained phenanthrene, benzo[b]fluoranthene and benzo[a]pyrene in the concentrations of 0.0005µg/kg, 0.0117µg/kg-and-0.0399 µg/kg respectively. It could only be seen that only 2 PAlis, acenaphthylene and benzojajpyrene were Quinined in the boiled sample in the concermatites of 08475g/kg and 0.0933µg/kg respectively as shown in tabie (1). The roasted sample oniy contained phenanthrene (0.0008µg/kg), Quorantheng (0.0016ug/kg) and benzujajχανικος 01293µγ/καλ. τουε ineu auri ivarixamed sammpics was inc host teavily loaded will the Past toer me Paris compound found in the two samples were in line with {13}. that food PAHs and increase the level of PAHs in the food being cooked.Also according-to-cooking processes especially the high temperature-ones are known to induce the production of potential carcinogens and also increase the levels of PARS in the food being prepared (14). Data indicated that the PAHs, in the samples varied, with the fried sample containing naphthalene (0.0030µg/kg) flourene (0.0355µg/kg), phenanthrene (0.0095µg/kg), fluoranthene (0.0079µg/kg), pyrene (3.294µg/kg), Benzolk fluoranthene (2.2733µg/kg), Benzo[a]pyrene (1.8249µg/kg) and indeno[1,2,3-ed]pyrene (3.3886µg/kg)... The result... also... gave the following PAHs and their_concentrations in the barbequed sample as naphthylene, fuorene, phenanthrene, Quoranthone pyrene, chrysene. benzolk fluoranthene and benzofalpyrene in the concentrations of 0.0073µg/kg, 0.0094µg/kg, 0.0044µg/kg, 0.0006µg/kg,

Among the PAHs found in the fried sample, three of them were among the PAHs which has been declared carcinogen by the IARC. These include benzo[k]fluoranthene, benzo[a]pyrene and indeno[1,2,3- cd]pyrene. Indeno[1,2,3-cd]pyrene has the highest concentration (3.3886µg/kg) followed by benzo[k] fluoranthene (2.2733µg/kg) then benzo[a]pyrene(1.8249µg/kg). The fried sample contained the highest concentration of the carcinogenic PAHs. This shows that the PAHs in both samples were as a result of pyrolitic processes. Acenaphthylene was not detected in the other samples but in the barbequed and boiled chicken. Chrysene was only found in the barbequed

chicken sample. However, indeno [1,2,3-cd]pyrene was detected in the fried chicken sample only and was the highest in concentration (16,17).

The results showed that naphthalene, a low molecular weight PAH was only found in the fried chicken sample at a concentration of 0.0030µg/kg. Acenaphthene, 1, 2- benzanthracene, dibenzo[a,h]anthracene and benzo[g,h,i]perylene were not detected in any of the samples. The obtained data proved that total carcinogenic PAHs were 0.0516, 0.0933, 7.4868, 0.1343 and 0.0.3610 µg/kg in the control, boiled, fried, barbecued and roasted chicken samples respectively. They showed that PAHs are incorporated in fats of chickens owing to their lipophilic nature. The figures (1-5) showing the levels and percentages of the 16 PAHs. (18-20)

Table 1: Levels of PAHs in the control and other four differently cooked chicken samples

Compounds	Raw chicken (control) (µg/kg)	Boiled chicken (µg/kg)	Fried chicken (µg/kg)	Barbecued Chicken (µg/kg)	Roasted Chicken (µg/kg)
Naphthalene	ND	ND	0.0030	ND	ND
Acenaphthene	ND	ND	ND	ND	ND
Acenaphthylene	ND	0.0475	ND	0.0073	ND
Fluorene	ND	ND	0.0355	0.0094	ND
Phenanthrene	0.0005	ND	0.0095	0.0044	0.0008
Anthracene	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	0.0079	0.0006	0.0016
Pyrene	ND	ND	3.2947	0.0448	ND
1,2 Benzoanthracene*	ND	ND	ND	ND	ND
Chrysene**	ND	ND	ND	0.0612	ND
Benzo[b]flouranthene**	0.0117	ND	ND	ND	ND
Benzo[k]flouranthene**	ND	ND	2.2733	0.0379	ND
Benzo[a]pyrene*	0.0399	0.0933	1.8249	0.0352	0.1793
In,2,3-deno[1cd]pyrene**	ND	ND	3.3886	ND	ND
Dibenzo[a,h]anthracene*	ND	ND	ND	ND	ND
Benzo[g,h,i]perylene	ND	ND	ND	ND	ND
Total PAHS	0.0521	0.1408	10.8374	0.2008	0.1817
Total Carcinogenic PAHS	0.0516	0.0933	7.4868	0.1343	0.3610

(ND): Not detectable. (*): IARC Group 2a: probably carcinogenic to human {15}.(**): IARC Group 2b: possibly carcinogenic to human {15}.(* and **): classified as carcinogenic to human {16-18}.

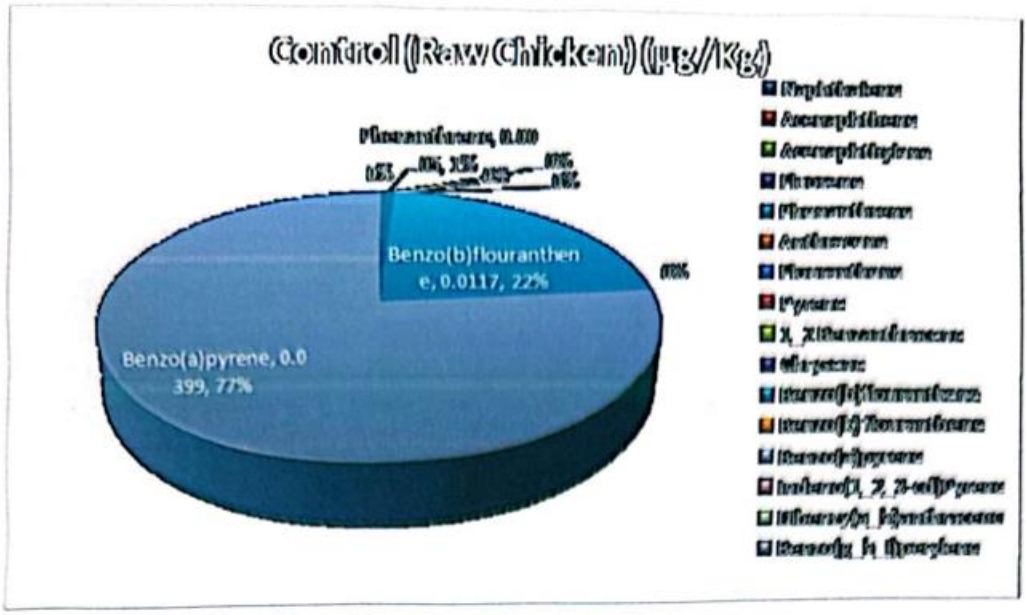

Figure 1: Chart showing the levels and percentages of the 16 PAHs in the control chicken sample.

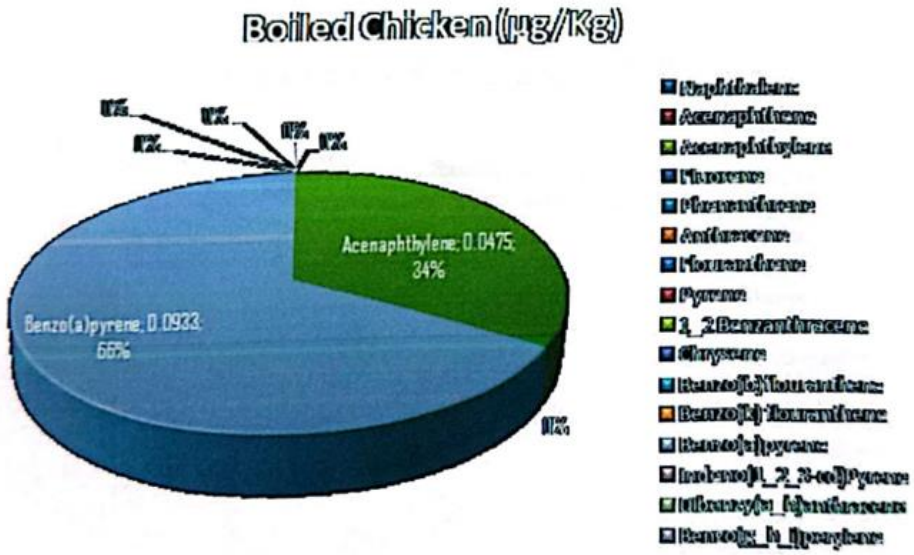

Figure 2: Chart showing the levels and percentages of the 16 PAHs in the boiled chicken sample.

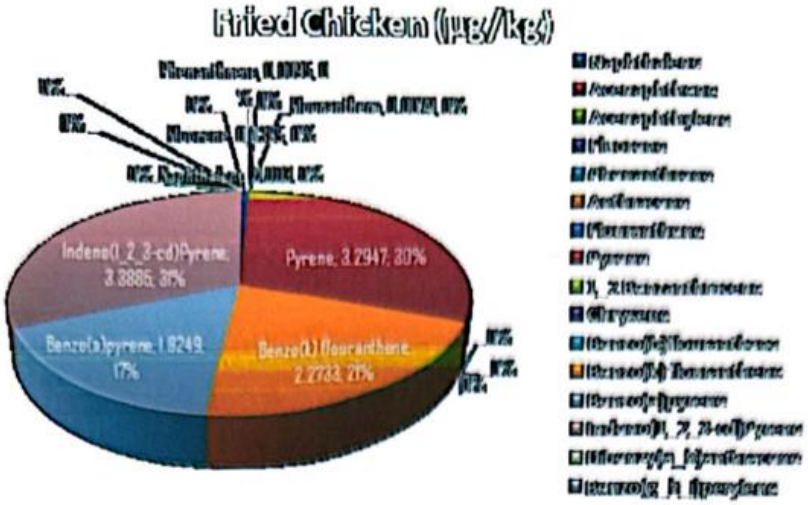

Figure 3: Chart showing the levels and percentages of the 16 PAHs in the fried chicken sample.

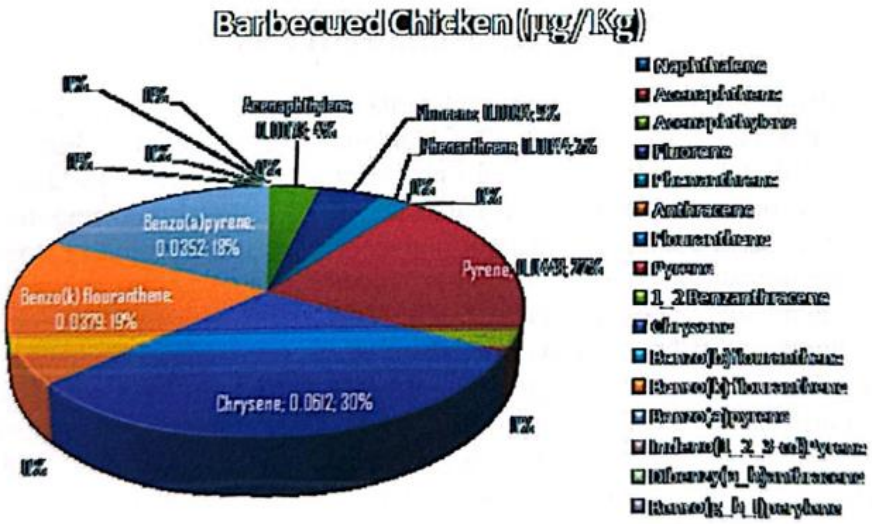

Figure 4: Chart showing the levels and percentages of the 16 PAHs in the barbecued chicken sample.

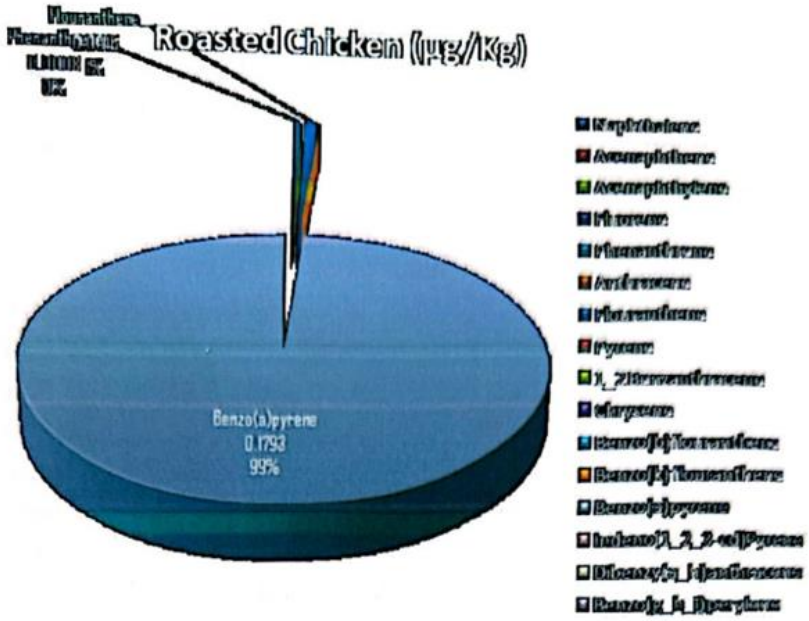

Figure 5: Chart showing the levels and percentages of the 16 PAHs in the roasted chicken sample.

Conclusion and Recommendation

The levels of the PAHs were strongly affected by the cooking methods, as boiling of all the four cooking methods had it safest. Though, the levels of PAHs in the samples were below the tolerance limit by the European regulations. The amount of PAHs formed during cooking or processing of food depends markedly on the conditions used. Simple practices are known to result in a significantly reduced contamination of foods by PAHs {19-20}as well as by other undesirable contaminants. This may include selecting preferentially lean meat and fishes, avoiding contact of foods with flames for barbecuing, using less fat for grilling, and, in general, cooking at lower temperature for a longer time. Broiling (heat source above) instead of grilling can significantly reduce the levels of PAH. Actually the fat should not drip down onto an open flame sending up a column of smoke that coats the food with PAHs. The use of medium to low heat, and placement of the meat further from the heat source, can greatly reduce formation of PAHs. However, cooking must always remain effective as regards inactivation of any possible contaminating bacteria or endogenous toxins.

REFERENCES:

1. Mariusz, S. Kubiaka, and Magdalena, P., pol. J. Natur, Sc., 30(2), 137-147, 2015.
2. Larsen, J. C. and Larsen, P. B., (1998) "Chemical carcinogens". In. R. E. Hester and R. M. Harrison, eds, Air pollution and health. Cambridge, UK, Royal Society of Chemistry, 33-56.
3. Walter, W., "Novel Developments On The Extraction And Analysis The

environmental samples ", PhD., Department of Chemistry, College of Science, University of Central Florida, Orlando, Florida, 2014.

4. Murakami, M. Sato, N. Anegawa, A. Nakada, N. Harada, A. and Furmai, H., Water Res., 42 (10-11), 2745-2755, 2008.
5. Kobayshi, R. Okamoto, R. A., Maddalena, R. L. and Kado, N. Y. Environ. Res., 107(2), 145-151, 2008.
6. WHO/IPCS, World Health Organization/ International Programme on Chemical Safety(1998).Environmental Health Criteria202: Selected Non-Heterocyclic Polycyclic Aromatic Hydrocarbon. International Program on Chemical Safety, United Nations Environmental Program, World Health Organization. Geneva.
7. EC (European Commission), (2002), Opinion of the Scientific Committee on Food on the risks to human health of Polycyclic Aromatic Hydrocarbon in food Toxicological profile for Polycyclic aromatic hydrocarbon.
8. Chatonnet, P. and Escobessa, J., J. Agric. Food Chem., 55, 10351- 10358, 2007.
9. 10-Onwukeme, V. I., Obijo, O. C., Asomugha, R. N. and Oka, F. A., Journal of Environmental Science, Toxicology and Food, 9 (4), 21- 27, 2015.
10. 11-El-badry, N., J. world Applied Sci., 9(9), 963-974, 2010.
11. Agerst, M. J., and skog, K., Mutation Research, 574,156-172, 2005
12. Ujowundu, C. O., Ihekweazu, K. L., Alisi, C. S., Ujowundu, F. N. and Igew, C. U., British journal of applied science and technology, 249-260, 2014.
13. 14-IARC-International Agency Research on Cancer (2006). Monographs on the evaluation of carcinogenic risk of chemical to humans, polynuclear aromatic compounds. Part 1: Chemical environmental and experimental data. Lyon, France. International Agency for Research on Cancer(IARC).
14. 15-U. S. EPA, United States Environmental Protection Agency (2002). Polycyclic Organic Matter, Environmental Protection Agency. Wagongion DC.
15. K.W., anal. Chem., 326, 401-413, 1987.
16. Larsen, J. C. and Larsen, P.P., UK. Royal Society of Chemistry, 33-56, 1998.
17. Lijinsky, W. and Ross, A.E., Food Cosmet. Toxicol, 5, 343-347, 1967.
18. Lijinsky, W., J. Mutt. Res, 259(3-4), 251-261, 1991.
19. Knize, M.G., Sinha, R., Rothman, N., Brown, E.D., Salmon, C. P. and Levander, O. A., Food and Chemical Toxicology, 33(7), 545- 551,1005