Scholars Academic Journal of Biosciences
Abbreviated Key Title: Sch Acad J Biosci
ISSN 2347-9515 (Print) | ISSN 2321-6883 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Food Science and Technology

Reduction of Polychlorinated Biphenyls (PCB) In Fresh Fish from the Grand Lahou Lagoon for Healthy Consumption

Hampoh Adé Hortense[1*], Ehouman Ano Guy Serge[2], Dalogo Kakou Alain Paterne[2], Brou Kouakou[1], Traore Karim Sory[3]

[1]Laboratory of Nutrition and Security Alimentaire, Department of Food Science and Technology, Nangui Abrogoua University, Abidjan, Côte d'Ivoire, 02 BP 801 Abidjan
[2]Jean-Lorougnon-Guédé Université, Daloa, Côte d'Ivoire
[3]Environmental Sciences Laboratory, Departement of Environmental Sciences and Management, Nangui Abrogoua University, Abidjan, Côte d'Ivoire, 02 BP 801 Abidjan

DOI: 10.36347/sajb.2023.v11i01.004 | **Received:** 05.12.2022 | **Accepted:** 17.01.2023 | **Published:** 23.01.2023

***Corresponding author:** Hampoh Adé Hortense
Laboratory of Nutrition and Security Alimentaire, Department of Food Science and Technology, Nangui Abrogoua University, Abidjan, Côte d'Ivoire, 02 BP 801 Abidjan

Abstract **Original Research Article**

The Grand Lahou lagoon system receives numerous spills from inland waters. This results in various forms of chemical pollution. Two species of fish most consumed by the Grand Lahou population are contaminated with high levels of Polychlorinated Biphenyls (PCBs). The objective of this study is to reduce the levels of PCBs in both fish species in order to provide consumers with healthy fish. The fish species most contaminated with PCBs, namely a type of catfish called ‘‘machoiron’’ (*Chrysichthys* sp.) and the mullet *(Mugil* sp.) were collected according to their weight (category 1:101-200g and category 2: 201-300g). Smoking has been proposed to reduce PCB levels. Thus two smoking techniques were used: smoking the fish traditionally using firewood as fuel and smoking on barbecue with charcoal. The level of PCB contamination in fish was determined by the gas chromatograph coupled with an electron capture detector (GC-ECD). The results obtained show that the smoking techniques used reduce the PCBi content. Wood smoking eliminates 98% of PCBs from fish compared to 88% for charcoal smoking.

Keywords: *Pollution, contaminated, fish, reduce, PCB, smoking*.

INTRODUCTION

Aquatic environments are one of the largest reservoirs of environmental pollutants such as Polychlorinated Biphenyls (PCBs) and heavy metals (Edder *et al.,* 2012).

Fish from these habitats are an important and regular source of protein for populations. Fish are very rich in protein, mineral salts, vitamins and lipids (Rieu 2012). However, fish consumption has been reported as an important route of human exposure to a variety of chemicals (Pandelova *et al.*, 2008; Schuetze *et al.*, 2010). The work of HAMPOH et al. (2014) showed high levels of PCBs in 2 species of fresh fish (Mullet: *Mugil sp* and Mâchoiron: *Chrysichthys sp*) most consumed by the population of Grand Lahou. The levels observed exceed the maximum residue limit of PCBi set at 125 µg/kg pf for freshwater fish according to the European standard. The presence of chemicals in food can have adverse health effects. Polychlorinated biphenyls (PCBs) have a ubiquitous, persistent nature. These molecules represent a group of highly toxic substances. Most of them are mutagens, teratogens, probable carcinogens, endocrine disruptors or enzyme inducers that may disrupt metabolism (Safe, 2005; Yang *et al.*, 2010; Crinnion, 2011).

To this end, the PCB content of these fish should be reduced. The objective of this study is to reduce PCB levels in fresh fish in order to present healthy fish to consumers.

1. MATERIALS AND METHODES

The fish species most contaminated with PCBs, namely a type of catfish called ‘‘machoiron’’ (*Chrysichthys* sp.) and the mullet *(Mugil* sp.) were collected according to their weight (category 1:101-200g and category 2: 201-300g) in the Grand Lahou Lagoon.

a) *Mugil* sp.

b) *Chrysichthys* sp.

Figure 1: Fish species studied

Table I: Number of fish per campaign

Fish species	Campaign 1	Campaign 2	Total/species
Mugil sp	36	36	72
Chrysichthys sp	36	36	72
Total fish	**72**	**72**	**144**

In Campaigns 1 and 2, the fish were divided into two sub-groups: the first was analysed in its raw state and the second was smoked before being analysed (Table I).

Two smoking techniques were used to reduce PCB levels: smoking with a traditional furnace using firewood as fuel and smoking on barbecue with charcoal. The charcoal used is obtained with the same wood species used for the previous smoking. The fish were smoked for 2 hours.

a) Fish smoking charcoal

b) Fish smoking in the woods

Figure 2: Fish smoking techniques

1-1 Determination of fat content

A test sample of 2 g of muscle was extracted per 20 mL of dichloromethane in microwave fields for 10 min at 30 W. The extract is then filtered on glass wool, recovered in a previously tared flask, and evaporated to dryness using a rotary evaporator. The lipid weight in the test sample is obtained by weighing the flask according to the method of Tapie *et al.*, (2006).

1-2 Determination of PCB contents

The method used to extract PCBs is the hydrolysis of fat using concentrated sulphuric acid (Kannan *et al.*, 1993, Wells and Echarri 1994).

The extracted fat is taken up with 10 ml of hexane and mixed with the vortex. Twenty (20) mL of sulphuric acid was added and the samples are put on the tumbler agitator for 8 hours. The extract is neutralized by adding de-ionized water, the supernatant is then recovered with a pastor pipette. This supernatant is then concentrated with rotavapor and resumed with 5mL of hexane. To remove compounds that may interfere with the desired molecules, the extracts have been purified. It is carried out on florisil columns (Magnesia and Silica Co-precipitate: 16% Mgo + 84% Sio) and 500 µL of sample are deposited on each column and then eluted successively with 20 mL of hexane and 20 mL of an

80:20% (V/V) dichloromethane mixture. The solution is re-condensed with theh rotavapor and then resumed with 2mL of hexane.

The purified samples are analyzed by the gas chromatograph coupled with an electron capture detector (GC-ECD) for the identification and quantification of PCB molecules. The indicator PCBs (CB 28, CB 52, CB 101, CB 118, CB 138, CB 153 and CB 180) were searched in the organic matrices.

Table II: Chromatograph Characteristics and Operating Conditions (GC/ ECD)

Characteristics	**HP 5890**
Column **Injection**	OPTIMA 1301 Column, 60 m long, 0,25 mm internal diameter and 0,2 µm film thickness 3 µL
Carrier gas	He at 1.21 bar, linear speed 35 cm.s-1
Injector	"on column" at 78°C
Programming of temperature	2 min at 80°C 30°C/min to 190°C 20°C/min (2min) to 240°C 2°C/min (23 min) to 260°C and 10°C/min (20 min)
Detector	CSE, source ^{63}Ni at 330°C

2. RESULTS

The elimination of chemical pollutants was demonstrated by determining the level of PCBi contamination and the fat content in smoked fish.

2-1 Fat content in different fish

Table III shows the fat content in the different fish conditions. Fat levels in fresh fish (2,69 ± 0,26 to 18,37 ± 1,07 %) are higher than in smoked fish (0,45 ± 0,05 à 3,90 ± 0,22 %). At the level of Category 1 fresh mullet, the rate of 2.69% was increased to 0.54% in coal-smoked fish to 0.80 ± 0.08% in wood-smoked fish. Similarly at the level of category 2 Machoiron (Chrysichthys sp.) the rate which was 18.37 ± 1,01% in fresh fish increases to 3.90 ± 0.22 in coal-smoked fish to 1.07 ± 0.26 in wood-smoked fish. There is a 60% to 96% decrease in the fat content in smoked fish.

Table III: Fat content (%) in different states and categories of fish

States of fish	**Mullet**		**Machoiron (*Chrysichthys sp.*)**	
	Category 1	Category 2	Category 1	Category 2
Fresh fish	2,69^{a} ± 0,26	3,98^{a} ± 0,14	13.27^{a}± 0.76	18.37^{a}± 1, 01
Fish smoked with coal	0.54 ^{b} ±0.05	1.34^{b}± 0.13	3, 26^{b}±0.10	3.90^{b}± 0.22
Fish smoked with wood	0.81^{b}± 0.08	1.20^{b}± 0.23	0.45^{c}± 0.05	1.07^{c}± 0.26

In the same column, the same letter indicates that there is no significant difference between the samples (P >0.05) (newman-keuls test).

2-2 Level of contamination of fish with PCBi

Table IV shows the PCBi concentrations of fresh fish and wood and charcoal smoked fish. Levels of PCBi in fresh fish (71.3± 12 to 551.56 ± 74.7 µg.kg^{-1} pf) are higher than levels in smoked fish (2.4±0.18 to 84.61± 3.8 µg.kg^{-1} pf). In the case of Category 3 fresh mullet, the level is increased from 71.3 ± 12 to 49, 02 ± 72 µg.kg^{-1} pf in coal-smoked fish and to 6.13± 0.50 µg.kg^{-1} pf in wood-smoked fish. And in Category 3 fresh Machoiron (Chrysichthys sp.), the level increases from 551.56 ±74.7 to 84.61 3.8 µg.kg^{-1} pf in coal-smoked fish to 11.04± 0.25 µg.kg^{-1} pf in wood-smoked fish. Of the two techniques, wood smoking reduces PCBs more with a rate of 91 to 98.5% compared to coal smoking with a rate of 31 to 93%.

Table IV: Mean value deviations of the Sum of the 7PCBi (µg.kg^{-1} pf) in different fish states (n=3)

State of the fish	**Mullet**		**Machoiron (*Chrysichthys sp.*)**	
	Category 1	Category 2	Category 1	Category 2
Fresh fish	156.9^{a} ±27.9	71.3^{a}± 12	287.7^{a}± 180.4	551.56^{a}± 74.7
Fish smoked with coal	10, 32^{b} ±1,24	49, 02^{b} ±8,72	34.03^{b}± 0.36	84.61^{b}± 3.8
Fish smoked with wood	2,4^{c} ±0,18	6.13^{c}± 0.50	6.15^{c}± 1.12	11.04^{c}± 0.25

In the same column, the letters are different so there is a significant difference between the PCB content and the fish states (P<0.05) (newman-keuls test).

3. DISCUSSION

Fresh fish tested have high levels of PCBi. This contamination varies and depends on the species and

weight of the fish. This general contamination is due to the ubiquitous nature of PCBs in the environment. The high levels of PCBi in the fish tested are believed to be due to pollution of the Grand Lahou lagoon, the study site. Actually, this lagoon is an area which is subject to many anthropogenic aggressions (Konan *et al*., 2008). Thus the two species of fish under study showed PCBi levels higher than the standard so to eliminate these levels, the fresh fish were smoked on wood and charcoal. This was demonstrated by the determination of the level of PCBi contamination and the fat content in smoked fish.

The results show that smoking techniques reduce PCBi levels. PCBi levels obtained with wood smoking are lower (2, 40 ± 0,18 to 11,04 ± 0,25 µg.kg^{-1} pf) than those obtained with coal smoking (10, 32 ± 1,24 to 84,61 ± 3,8 µg.kg^{-1} pf). These results could be explained by the fact that wood would produce more flame (heat) to melt the fat contained in the fish. In fact, the fat content obtained in wood-smoked fish (0.45 to 1.47%) is lower than that obtained in coal-smoked fish (0.54 to 3.90%). So we're seeing a lot of fat removal from the wood-smoked fish, which has also led to a decline in PCBi. The elimination of PCBis by the melting of fat would be explained by the fact that PCBs are lipophilic molecules that are stored in organisms, primarily in fatty tissues (Muir *et al*., 2003).

CONCLUSION

Wood smoking eliminates 98% of PCBi from fish compared to 88% for coal smoking. Wood-smoked fish are more recommended for consumption because they have fewer PCBs. However, wood smoking allows the production of other types of pollutants, namely polycyclic aromatic hydrocarbons (PAHs). It would therefore be interesting to check the level of PAH contamination of these smoked fish and propose solutions to deal with it.

REFERENCES

- Crinnion, W. J. (2011). "Polychlorinated biphenyls: persistent pollutants with immunological, neurological, and endocrinological consequences." Alternative Medicine Review: *A Journal of Clinical Therapeutic*, 16, 5-13.
- Edder, P., Ortelli D., & Klein A. (2012). Micropolluants dans plusieurs espèces de poissons du léman micropollutants in fish species from lake geneva. *Rapp.Comm.int.prot.eaux Léman contre pollut., Campagne 2012*, 70-81.
- Hampoh, A. H., Ehouman A. G. S., Brou K., Traore, K. S., Kone M., & Dembele A. (2014). Niveau de contamination en Polychlorobiphenyles (PCB) dans les poissons frais pêchés dans la lagune de Grand-Lahou (Côte d'Ivoire), European scientific journal 10, 116 - 131.
- Kannan, N., Reusch, T. B. H., Schulz-Bull, D. E., Petrick, G., & Duinker, J. C. (1995). Chlorobiphenyls: Model compounds for metabolism in food chain organismsand their potential use as ecotoxicological stress indicators byapplication of the metabolic slope concept. *Environmental Science and Technology*, 29, 1851-1859.
- Konan, S. K., Kouassi, A. M., Adingra, A. A., Dongui B. K., & Gnakri D. (2008). Variations saisonnières des paramètres abiotiques des eaux d'une lagunes tropicale: la lagune de Grand-Lahou, Côte D'Ivoire, *European Journal of Scientific Research*, 21, 376-393.
- Muir, D., Savinova, T., Savinov, V., Alexeeva, L., Potelov, V., & Svetochev, V. (2003). Bioaccumulation of PCBs and chlorinated pesticides in seals, fishes and invertebrates from the White Sea, Russia. *The Science of the Total Environment*, 306, 111-131.
- Pandelova, M., Henkelmann, B., Roots O., Simm, M., Järv, L., Benfenati, E., & Schramm, K. W. (2008). Levels of PCDD/F and dioxin like PCB in Baltic fish of different age and gender. *Chemosphere*, 71, 369-378.
- Rieu, D. (2012). Composition des poissons: protéines, lipides, vitamine D, iode… *Archives de Pediatrie*, 19, H36-H37.
- Safe, S. (2005). "Clinical correlates of environmental endocrine disruptors." *Trends in Endocrinology and Metabolism*, 16, 139-144.
- Schuetze, A., Thomas Heberer, T., Effkemann, S., & Juergensen, S. (2010). Occurrence and assessment of perfluorinated chemicals in wild fish from Northern Germany. *Chemosphere*, 78, 647–652.
- Yang, F., Zhang, Q., Guo, H., & Zhang, S. (2010)."Evaluation of cytotoxicity, genotoxicity and teratogenicity of marine sediments from Qingdao coastalareas using *in vitro* fish cell assay, comet assay and zebrafish embryo test."*Toxicology in Vitro*, 24, 2003-2011.
- Wells, D. E., & Echarri, I. (1994). Determination of chlorobiphenyls, with the separation of non-ortho, mono-ortho and di-orthochloro congeners in fish and sea mammals. *Analytica Chimica Acta*, 286, 431-449.