PERSISTENT ORGANIC POLLUTANTS IN MUSCLE OF YELLOWFIN TUNA (*Thunnnus albacares*) FROM THE ATLANTIC OCEAN

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Introduction

Persistent organic pollutants (POPs) represent a very diverse group of chemicals for industrial or agricultural use, with high lipophilicity and high resistance to metabolic degradation. These compounds are ubiquitous contaminants in aquatic environment as a result of uncontrolled spillage, river and streams transport, surface run-off and atmospheric deposition[1]. POPs, such as polychlorinated biphenyls (PCBs) and DDTs, are of a great concern because they are prone to bioaccumulate in aquatic organisms and biomagnified through the food web.

The major route of exposure of substances reported to humans is the ingestion of contaminated food, and fish consumption is probably the main source of these environmental contaminants. Thus, a somewhat refined analytical tool is essential for the study of such contamination in fish, particularly in predatory fish species of greatest economic value, such as tuna. The global catch of yellow fin tuna (YFT) was around one million tons in 2008, when this specie was among the world's 10 most fished[2]. In this perspective, the present study attempts to investigate the status of PCBs and DDTs contamination and the accumulation profile of individual PCB congeners in muscle of YFT from Atlantic Ocean.

Materials and methods

Forty specimens of YFT (twenty males and twenty females) were caught in the St. Peter and St. Paul archipelago situated in the Atlantic Ocean at 00º 55' N and 29º 21' W between April and May 2009 (Fig.1). After dissection, all samples were freeze-dried and wrapped in aluminum foil, until the moment of the analysis.

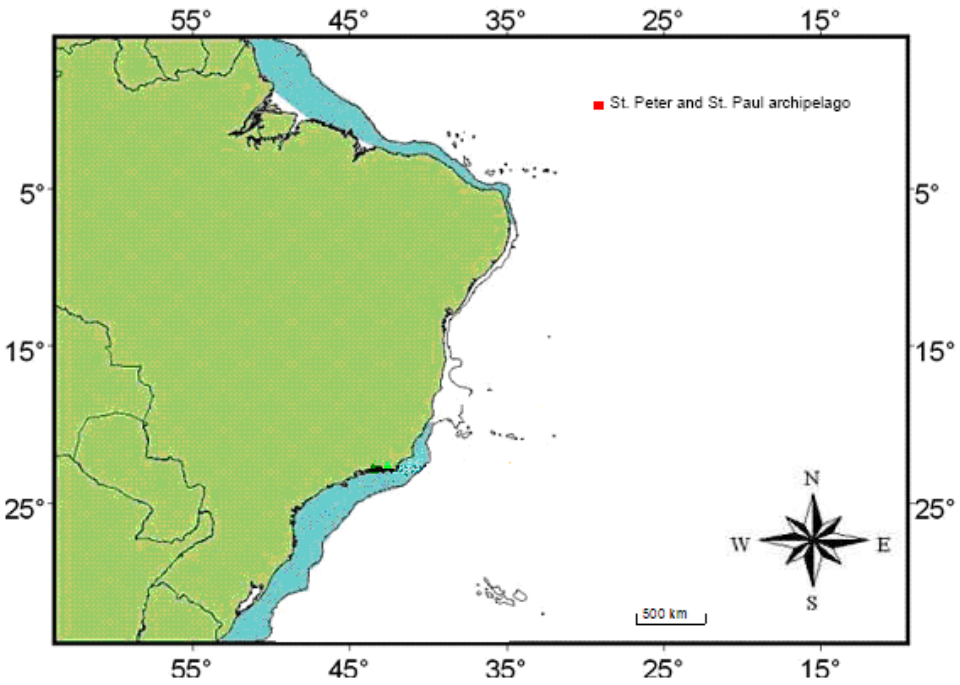

Figure 1 – Location of the St. Peter and St. Paul archipelago.

Polychlorinated biphenyls (PCBs) and DDT and its metabolites were analyzed following the method described by Azevedo-Silva *et al*[3]. Briefly, about 6 g of dried muscle tissue were homogenized with anhydrous Na2SO4 (1:1) and extracted by Soxhlet apparatus for 8 hours with a mixture of n-hexane: dichloromethane (1:1). After concentrating the extract solvents an aliquot (1mL) was mixed with sulfuric acid for the cleanup. After centrifugation, the organic phase was collected and the acid phase was washed with 2ml de n-hexane. The total organic portion was concentrated (1ml) and washed with 2 ml of ultrapure water. The top layer was transferred to a glass column (i.d. 7mm) filled with 1 g. of florisil (activated at 160 ^{o} C for 12 h) covered with 1g. of anhydrous Na2SO4. After elution with 15 ml (15:85 dichloromethane: n-hexane), the extract was concentrated and internal standard (TCMX, 2-4-5-6 Tetrachlorometaxylene) was added for quantification[1]. The lipid content was measured gravimetrically. A Shimadzu GC-2010 with a ^{63}Ni electron capture detector (ECD) with a 63Ni electron capture detector (ECD) was used in the analyses. Organochlorine concentrations are expressed as ng/g wet weight. IAEA-435 (tuna homogenate) was used as a reference material. The recoveries for each PCB and DDTs quantified in the certified material ranged from 70% to 130%. The analyzed organochlorines were: total DDT (p, p'–DDT, o, p'–DDT, p,p'–DDD, o, p'–DDD p, p'–DDE e o, p'–DDE) and 27 isomers and congeners (IUPAC numbers: 18, 28, 31, 44, 49, 52, 70, 87, 99, 101, 105, 118, 128, 138, 151, 153, 156, 170, 174, 177, 180, 183, 187, 194, 195, 206, 209.

Results and discussion

Organochlorine compounds (OCPs) were detected in all samples of YFT and the values summarized in Table 1. There was no significant correlation between fish fork length and lipid content (Spearman's test; $p > 0,05$). Only the correlation between total DDT and fork length was statistically significant (Spearman's test; $p < 0,01$). None of the OCP concentrations had a normal distribution for the pollutant concentrations (Shapiro-Wilk, $p < 0.05$). A significant difference was found for the total PCBs concentrations among males and females (Mann-Whitney ; $p = 0,014$).

Table 1 – Lipid content (%), fork length (cm) and ΣDDT and ΣPCB concentration ($ng.g^{-1}$ on lipid weight in muscle of yellow fin tuna from St. Peter and St. Paul archipelago. Numbers from top to bottom are: minimum and maximum values, means and median.

YFT	*Fat (%)Muscle*	*Fork Length (cm)*	*ΣDDT ($ng.g^{-1}$ l.w.)*	*ΣPCB ($ng.g^{-1}$l.w.)*
	0,96 – 6,3	90 – 138	15,77 – 178,7	116,15 – 2556,1
N=40	2,4	112,1	77,52	518,23
	2,14	112,5	66,54	384,84

Compared to previous works with tunas and correlated species, our results revealed a moderated contamination of ΣDDT and ΣPCB in YFT from the Atlantic Ocean. DDT concentrations of 1040 $ng.g^{-1}$ l.w, 290 $ng.g^{-1}$ l.w and 200 $ng.g^{-1}$ l.w., were measured in the muscle of YFT, Pacific blue fin tuna and albacore tuna, respectively, collected from the Pacific Ocean[4]. The more persistent metabolite p,p'-DDE was the predominant compound among total DDTs in YFT muscle, accounting for 60,57%.

The concentration of the total analyzed PCBs (sum of f 27 congeners) in muscle ranged from 116,15 – 2556,1 ($ng.g^{-1}$ l.w. (Table 1). Results of this study were lower than those from previous works on tuna and correlated species contamination from different oceans worldwide. The PCB concentrations of 17 – 16839 $ng.g^{-1}$ l.w. were observed in the muscle of bluefin tuna sampled in the Mediterranean Sea[5]. the highest concentrations were found of congeners PCB-52-, PCB-31, PCB 101, PCB 28, and PCB-153 PCB-44, which together account for more than 60% of total PCB. They revealed the prevalence of the least chlorinated congeners. The profile of congeners found in this study is markedly different from that observed in studies with other species of tuna and oceanic pelagic fish from different geographical regions in which the hexa- and heptachlor congeners are the most abundant [6,7]. Ueno and colleagues (2005) emphasized the predominance of less chlorinated PCB congeners in samples of skipjack tuna captured in the northern hemisphere, compared to those of tropical regions. This fact was correlated with the hypothesis that there is more atmospheric transport of these compounds to high latitudes. The profile of congeners mentioned is closer than found in this study[8].

The concentrations of total DDT and PCBs found in YFT muscles were below the limits of consumption established by Brazil. The probable daily intake values for total DDT and PCB-TEQ were lower than the acceptable daily intake recommended by World Health Organization. Indeed, these fish can be considered safe for consumption, since there is a positive relationship between levels of contaminants in fish and adverse effects to human health

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References
1. Di Bella, G., Licata, P., Bruzzese, A., Naccari, C., Trombeta, D., Lo Turco, V., Dugo, G., Richetti, A., Naccari, F. (2006). Environ. Intern. 32(6):705-710.
2. SOFIA (The State of World Fisheries and Aquaculture) – FAO, 2010 at http://www.fao.org/docrep/013/i1820e/i1820e.pdf
3. Azevedo-Silva, C.E., Azeredo, A., Lailson-Brito, J., Torres, J.P.M., Malm, O. (2007); Chemosphere. 67(9):S48-S53.
4. Hisamichi, Y., Haraguchi, K., Endo. (2011); Environ. Sci. & Techn. 44 (15): 5971-5978.
5. Corsolini, S., Borghesi, N., Schiamone, A., Focardi, S. (2007); Environ. Sci. Pollut. Res. 14:421-429.
6. Domingo, J. L. & ocio, A. (2007); Environ. Intern. 33(3): 397–405.
7. Storelli, M.M., Giacominelli-Stuffler R., D'addabo R., Marcotrigiano, G.O. (2003); Journal of Food Protection. 66(11): 2176-9.
8. Ueno, D., Watanabe, M., Subramanian, A., Tanaka, H., Fillman, G., Lam, P.K.S., Zheng, G.J., Muchtar, M., Razak, H., Prudence, M., Chung, K., Tanabe, S. (2005); Environ. Pollut. 136(2): 303-313.