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Assessment of mercury content in Panga (*Pangasius hypophthalmus*)

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HIGHLIGHTS

- The consumption of panga is increasing due to its low price.
- Panga comes from areas with high levels of pollution.
- Mercury bioaccumulates and biomagnifies along the food chain.
- The mercury level in some samples exceeded the maximum limit.
- Intake of mercury from panga may pose a health risk.

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ABSTRACT

Panga (*Pangasius hypophthalmus*), originating from Vietnam, is one of the most consumed fish because of its low cost, mild taste and presentation (fillets without skin and bones). Nevertheless, due to the high levels of contamination of the rivers where it lives, and to the fact that the panga is a predator, whereby it will accumulate a higher mercury concentration, the main objectives of the present study were to evaluate the toxic risk from mercury ingestion as a result of the consumption of this fish. A total of 80 frozen panga samples natural and marinade from different commercial establishments have been analyzed using cold vapour atomic absorption spectrophotometry (CV-AAS). The results obtained show a wide range of mercury concentrations between 0.10 and 0.69 mg/kg, with an average value of 0.22 mg/kg. In addition, it has been found that the average mercury concentration in the marinated presentation (0.18 mg/kg) is higher than that obtained in the natural panga (0.16 mg/kg). However, no significant differences were found between commercial establishments or in the presentation formats, with the conclusion that they did not influence the mercury content in the samples. Assuming a weekly consumption of 350 g of panga, the contribution rate to Tolerable Weekly Intake (TWI) of mercury (4 μg/kg bw/week) is 32% and 27.5% for women and men, respectively. Based on the results obtained in this study, an exhaustive control of the mercury content in this type of fish is necessary. In addition, a consumption restriction to children will be established.

1. Introduction

Panga (*Pangasius hypophthalmus*) is among the most consumed fish in Europe, both domestically and in the hotel and catering sector. Panga is a low-priced, mild-tasting fish whose retail presentation as skinned and boned fillet has led to increased consumption (Little et al., 2012).

Pangasius hypophthalmus (Sauvage, 1878) is a kind of fresh or brackish water originating from the Mekong River (Vietnam). It is an omnivorous and predatory fish in its natural habitat, whose diet is based on rice bran, soy and other fish products (Ruiz-de-Cenzano et al., 2013), and therefore, panga is the final predator, it tends to accumulate higher concentrations of metals, such as mercury, due to biomagnification in the food chain (Nelson, 1994; Ferrantelli et al., 2012; Adel et al., 2016). In addition, due to contamination from human activities, the habitat of panga, the Mekong River, is contaminated. The contamination in the Mekong River is mainly caused by the pesticides and other chemical compounds used in the

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rice crops, which are close to the river and the inexistence of a sewage depuration system. As a consequence of the above, the panga itself is heavily contaminated (WHO, 2003; Ferrantelli et al., 2012). On the other hand, the nutritional profile of this fish species is not of great value with low protein content (13.4 g per 100 g of product) and a lower omega-3 level than other species (Orban et al., 2008).

The main route of incorporation of metals into humans is through the diet (Islam et al., 2007; Prieto-Méndez et al., 2009). In the case of mercury, the main food sources are contaminated fish (Kurosaki et al., 2000; Adel et al., 2016).

Mercury is a toxic metal, which has no biological function and tends to accumulate in living organisms causing dysfunctions in the biological system (Rubio et al., 2008; Turconi et al., 2009; Nasreddine et al., 2010; Miklavcic et al., 2013). Inorganic mercury in the aquatic environment is transformed into methyl mercury by a special group of bacteria, the result of this process is the production of free methyl mercury that is absorbed by the plankton and smaller fish which are eaten by bigger fish such as the panga, so the result is a high concentration of mercury. In addition, the mercury absorption depends on several physiological properties of the fish such as age, sex, length, etc. (Berlin et al., 2007; Paz et al., 2017). Mercury and especially methyl mercury, mainly accumulates in the brain as it is a neurotoxic agent that causes different types of damage to the central nervous system (CNS) and affects the gastrointestinal tract and renal function (Hardisson, 1981; Sierra and Hardisson, 1991; Berlin et al., 2007; Bernhoft, 2012; Olmedo et al., 2013; Paz et al., 2017; Grandjean, 2017).

Due to the toxicity of mercury and its high concentration in fish products, the European legislation has established a maximum mercury limit of 0.5 mg/kg for white fish products (EC, 2006). On the other hand, the European Food Safety Authority (EFSA) has established a Tolerable Weekly Intake (TWI) of 4 μg/kg bw/week for inorganic mercury (EFSA, 2012).

Therefore, in view of the high consumption of panga (*Pangasius hypophthalmus*) in Europe, the high level of contamination of their habitat and the toxicity of mercury, this study was carried out in order to quantify mercury levels in samples of panga (in marinated and natural formats) from different commercial establishments, to estimate the intake of this metal and to evaluate the risk from panga consumption.

2. Material and methods

2.1. Sampling

A total of 80 samples of frozen panga fillets (P. hypophthalmus), which came from Vietnam, from different commercial establishments and of different types (natural and marinated), as described below:

Hypermarket 1: 21 samples in marinade and 20 natural samples.

Hypermarket 2: 19 natural samples.

Hypermarket 3: 20 natural samples.

2.2. Treatment of samples

Frozen panga fillets were thawed in the refrigerator at 4 °C for 24 h. Once thawed, they were allowed to reach room temperature before being weighed.0.2 mg of each sample was weighed in a model 4744 acid digestion pump with a Parr Instrument Teflon sample vessel, adding 5 mL of 1:1 sulfonitric solution, previously prepared and placed in the oven at 40 °C for 24 h. After that time, the samples were put in 10 mL volumetric flasks with 1.5% HNO_3.

2.3. Method and quality control

The determination of mercury was carried out by cold vapour atomic absorption spectrophotometry (CV-AAS).

This method is used for the determination of mercury because it is a volatile metal at low temperatures, so it can be atomized and determined as cold vapour. The determination proceeds after the addition of a reducing agent ($SnCl_2$) to the sample previously digested to release the mercury via a reduction reaction after which volatile atomic mercury is obtained which is conveyed to the spectrophotometer cell (IUPAC, 1998).

In order to ensure the accuracy of the method, the quality control was performed prior to the analysis of the samples.

An Hg recovery study was carried out following various digestion procedures with strong acids and Lumatom (special digestive solution for the treatment of mercury). The recovery percentages obtained for each oxidizing agent used are shown in Table 1. The 1:1 sulfonitric solution used in the digestion treatment of the samples was the one with the highest recovery percentage (Hardisson et al., 1999).

Table 2 shows the results of the mercury concentrations obtained with the reference materials used (NIST SRM 1577 BL or bovine liver and BRC-278 R MT or mussel tissue) for different digestion procedures (Microwave and 1:1 sulfonitric solution) (Hardisson et al., 1999).

2.4. Statistical analysis

Statistical analysis was performed using the IBM Statistics SPSS 22.0 program. The normality of the samples was checked by the Kolmogorov-Smirnov and Saphiro Wilk test and the Levene test of homogeneity of the variances (Gutiérrez et al., 2008). In the absence of normal data, non-parametric tests were used using the Kruskal-Wallis test (Choy et al., 2001; Rubio et al., 2017a, b). This statistical analysis was performed in order to confirm the existence or not of significant differences between the different samples according to their presentation (natural or marinated).

3. Results and discussion

Table 3 shows the concentrations of mercury (mg/kg) obtained in each sample analyzed and the average concentration obtained according to the commercial establishment and the format of the product.

The mercury concentrations range from 0.1 to 0.69 mg/kg. Taking into account the maximum mercury limit set by European legislation at 0.5 mg/kg, some of the samples analyzed are close to or above that limit.

As for the commercial establishment, the highest average concentration of mercury was found in Hypermarket 2 (0.27 mg/kg), while the lowest concentration was found in Hypermarket 3. However, statistical analysis did not find significant differences with respect to commercial establishment.

Depending on the type of coating liquid of the product, the

Table 1
Statistical study of the recovery of several mineralization procedures for the determination of Hg.

Oxidizing agent/mL	°C/h	Reactor	% Recovery	P^2
H_2SO_4/HNO_3/10 (1:1)	45/15	No	96.7 ± 5.0	>0.05
HNO_3/10	100/1	Yes	86.2 ± 3.8	<0.01
H_2SO_4/HNO_3/10 (1:1)	100/1	Yes	83.8 ± 3.4	<0.01
H_2SO_4/HCl/10 (1:1)	100/1	Yes	82.8 ± 4.8	<0.01
Lumatom/5	45/24	No	93.7 ± 5.0	<0.01