Zagazig Veterinary Journal, ©Faculty of Veterinary Medicine,
Zagazig University, 44511, Egypt.
Volume 47, Number 2, p. 193-202, June 2019
DOI: 10.21608/zvjz.2019.10727.1031

RESEARCH ARTICLE

Risk Assessment of some Heavy Metals from *Claris gariepinus* (African catfish) Consumed in Sharkia Governorate, Egypt

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Article History: Received: 17/03/2019 Received in revised form: 11/04/2019 Accepted: 14/04/2019

Abstract

This study was conducted to determine the residual concentrations of lead (Pb), cadmium (Cd), mercury (Hg) and Arsenic (As) in *Claris gariepinus* from Abou Hammad, Zagazig and Faqous fish markets at Sharkia Governorate, Egypt, to assess such metals dietary intake, and to evaluate the possible health risks linked with the fish consumption. Therefore, ninety *Claris gariepinus* samples, 30 of each, from Abou Hammad, Zagazig and Faqous fish markets were analyzed using atomic absorption spectrophotometer (AAS). The obtained results showed that, the mean residual concentrations in *Clarias gariepinus* from Abou Hammad, Zagazig and Faqous fish markets were 0.08±0.02, 0.19±0.02 and 0.4±0.06 ppm for Cd, respectively. While, the results of Pb were 0.45±0.07, 0.42±0.04 and 0.51±0.08 ppm, respectively; 0.59±0.15, 1.02±0.08 and 0.15±0.03 ppm for Hg, and 0.74±0.06, 0.69±0.04 and 0.64±0.08 ppm for As. The estimated metals' concentration exceeded the recommended safety limits outlined by Egyptian standards (ES No 7136/2010) for most samples. The total estimated daily intakes (EDI) of Cd, Pb, Hg and As were 1, 3.57, 0.57and 2.14 µg/kg BW/day, respectively, that were less than the tolerable daily intake (TDI) suggested by the Joint Expert Committee on Food Additives (JECFA). Referring to the potential health risks of inspected *Claris gariepinus*, it was valued that the target hazard quotient (THQ) of As of all *Claris gariepinus* samples from Abou Hammad, Zagazig and Faqous fish markets were 1.34, 1.25, 1.16, respectively. These results were more than 1, representing possible health risks, while THQs of other metals (Pb, Cd, Hg) from *Claris gariepinus* consumption from all examined areas were lower than 1 as compared to the reference doses. The obtained results give us an alert that the consumer could be under health hazards so that further investigation of *Claris gariepinus* is recommended at Sharkia Governorate.

Keywords: *Claris gariepinus*, Heavy metals, Tolerable Daily Intake, Target Hazard Quotient, Health hazards.

Introduction

Fish is an essential source of food necessary for the human body, as it contains proteins, minerals, essential fatty acids especially omega 3, vitamins and often low fat content that attracted consumers due to health benefits [1]. Fish present at the peak of the sea food chain that can accumulate toxic metals in its tissue along its life [2]. Heavy metals enter the aquatic environment through soil erosion, atmosphere, drainage and all the anthropogenic activities as agricultural, industrial and domestic source [3].These metals can arrive to man through consumption of such contaminated fish [4].Toxic metals include cadmium (Cd), lead (Pb), Arsenic (As) and mercury (Hg) have severe health hazards**.** Human exposure to such metals can cause numerous acute and chronic adverse conditions as the carcinogenic and neurotoxic effects [5]. The cadmium toxicity is associated with its interactions with essential elements such as zinc leading to respiratory symptoms and renal dysfunction [6].The major effects of lead are reproductive dysfunction, nephropathy, hypertension, damage of nervous systems and gastrointestinal track damage [7]. Mercury is a neurotoxic that causes gastrointestinal toxicity, renal damage and neuro-behavioral dysfunction [8].

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The potential health risk of these elements on human health can be assessed through comparing the estimated dietary exposures with the recommended Tolerable Daily Intakes (TDIs) [9]. Besides, assessment of the target hazard quotients (THQ), if the THQ is below than one, the *Claris gariepinus* has no health risk. Therefore, in order to evaluate the human health risks via *Claris gariepinus* consumption, it is necessary to determine the residual concentrations of Pb, Cd, Hg and As in *Claris gariepinus* collected from three areas at Sharkia Governorate, Egypt. In addition to, the dietary intake estimation of toxic metals and estimation the hazard related to consumption of such fish.

Materials and Methods

Samples collection

Ninety samples of *Claris gariepinus* (African catfish) retailed for human consumption at three fish markets area from Sharkia Governorate, Egypt (Abou Hammad - Zagazig and Faqous fish markets) (30 of each) were randomly collected. The fish samples (nearly 150 gm, each) was placed in polyethylene bag and transported to the Central Laboratory, Faculty of Veterinary Medicine Zagazig University in an icebox, then immediately prepared for heavy metals analysis.

Digestion and analysis of samples

One gram of each fish muscle sample was placed in a clean screw capped tube contained 5 ml acid mixture (3 ml nitric acid (HNO_3):2 ml percholeric acid ($HCLO_4$) and digested according to Zantopoulos *et al.* [10]. The resultant solutions were then analyzed for determination of cadmium, lead and total arsenic.

Blank solution was prepared to check the possible trace of metals present in the deionized water or the acids used in dilution and digestion of the samples. Owing to mercury volatilization that occurred at temperature below 100ºC, this process was determined according to Diaz *et al*. [11] for determination of mercury at minimal temperature.

Samples Analysis

The samples were analyzed for heavy metals content by using Atomic Absorption Spectrophotometer (Perkin Elmer model specta-AA10, USA). Analysis of Cd, Pb and As was conducted by air/acetylene flow (5.5/1.11ml) flame atomic absorption spectrophotometer (AAS) whereas for Hg determination, cold vapor technique was applied using flame A.A.S set with M.H.S (mercury hydride system).

The obtained results were articulated as μg/g wet weight (ppm), and they were compared with Egyptian standard (ES) [12].

Estimated Daily Intake (EDI)

It is essential to evaluate the daily intake of metals from *Claris gariepinus* consumption and to compare it with the tolerable daily intake (TDI) values determined by international organizations for health safety. The EDI was estimated using the equation described by the US Environmental Protection Agency, EDI= (Cm x FIR)/BW [13], where Cm is the heavy metals concentration in the examined sample (mg/kg wet weight); FIR is fish ingestion rate (38.13 g/day) [14]; BW is the body weight of Egyptian adults (70 kg). Then the EDI was compared to TDIs [15].

The permissible tolerable weekly intake (PTWI) has been set by Joint Expert Committee on Food Additives (JECFA), as 7 μg/kg BW/week (equivalent to 1 μg/kg BW/day) for cadmium, 25 μg/kg BW/week (equivalent to 3.57 μg/kg BW/day) for lead, 5 μg/kg BW/week, which is corresponding to 0.71 μg/kg BW/day for total mercury and 15 μg/kg BW/week which is corresponding to 2.14 μg/kg BW/day for arsenic inorganic form (FAO/WHO/ JECFA, 2011). The ‘tolerable intake’ is commonly applied to explain the levels of safe intake and can be expressed on either a tolerable daily intake basis (TDI) or a tolerable weekly intake basis (TWI). The tolerable intake of heavy metals that situated by the FAO/WHO [15] is the greatest amount of a toxic metals to which a person can be subjected per day over a lifetime duration lacking an undesirable danger of health.

Target Hazard Quotient (THQ)

The health hazard of Egyptian people from *Claris gariepinus* consumption was evaluated by assessment of THQ. Target Hazard Quotient is the proportion between the exposure and the oral reference doses (RFD). The reference dose is the daily exposure of the estimation pollutant to which the people continuously exposed through a life without any hazard [16]. The reference oral dose value for Cd, Pb, As and Hg is 0.001, 0.004, 0.0003 and 0.0016 (mg/kg BW/day), respectively [17]. The population might expose to health hazad if the THQ is higher than one. The Risk assessment was calculated by the following equation [18]:

$$THQ = \frac{EF \times ED \times FIR \times C}{RFD \times BW \times AT} x10^{-3},$$

where, AT is the exposure time average (365 days/years of exposure, assumed as 70 years), BW is the body weight average (70 kg), RfD is the oral reference dose (mg/kg BW/day), C is the heavy metal concentration in fish (µg/g), FIR is the rate of food ingestion (g/person/day), ED is the average duration of exposure (70 years) and. EF is the frequency of exposure (365 days/year).

Hazard index (HI)

The hazard index (HI) has been performed to assess the probable human health hazard between more than one metal. The HI refers to the sum of all THQ for various metal exposures as described in the following equation:

$HI = \Sigma TTHQs = THQ\ Cd + THQ\ Pb + THQ\ As + THQ\ Hg$

As Σ TTHQs is the target hazard quotients of all metals and THQ Cd; THQ Pb; THQ As and THQ Hg are the target hazard quotients for cadmium, lead, arsenic and mercury, respectively. When the hazard index become over 1, possible human health risk is expected [19].

Statistical data analysis

Statistical analysis of the data was done using One-Way analysis of variance (ANOVA) (SPSS version 22). Results were tabulated as means ± standard error. Significant differences among the means were determined by Duncan's multiple comparisons test considering the p-value ≤ 0.05 statistically significant.

Results and Discussion

The results obtained in Table (1) showed that Cd concentration in the examined *Claris gariepinus* were 0.08±0.02, 0.19±0.02 and 0.4±0.06 ppm from Abou Hammad, Zagazig and Faqous fish markets, respectively. Cadmium levels were in the order of Faqous> Zagazig > Abou Hammad with a significant effect ($p<0.05$). Fish samples that collected from Faqous city mainly were reared in fish farms using the Bahr El-Baqar water, which had the highest metal accumulation because it is the most polluted area that receives more industrial, domestic and agricultural drainage water than other areas. These results were lower than 0.66, 0.49, 0.78 and 0.55(mg/kg) in *Claris gariepinus* from Aswan, Kena, Damietta and Rosetta, respectively [20]. The mean Cd concentration in *Claris gariepinus* from Abou Hammad was lower than 0.20 mg/kg in *Claris gariepinus* from Assiut and 0.354 mg/kg from Beni-Suef [20]. Lower Cd concentrations (0.033 ± 0.005 ppm) in Nile catfish (*Claris gariepinus*) was reported by Hashim *et al*. [21] and 0.14 ± 0.02 mg/ kg in *Claris lazera* from Shebin El-kom, Menofia governorate [22]. In addition, Cadmium concentration ranged from 0.19 to 0.29 mg/ kg in *Claris gariepinus* from six sites of the River Nile, Rosetta branch, Behira (Egypt) [23]. A percentages of 60%, 100% and 100% of the examined *Claris gariepinus* from Abou Hammad, Zagazig and Faqous fish markets, respectively exceeded the accepted permissible limits (0.05ppm) recommended by ES.NO. (7136) [12] **(**Table, 2**)** and considered unsafe for human consumption.

Table 1: Statistical analytical results of some heavy metal residues (ppm) in the examined *Claris gariepinus* samples (No=30 each) collected from different fish markets at Sharkia Governorate

Heavy metals		Abou Hammad	Zagazig	Faqous
Cd	Minimum	0.03	0.14	0.32
	Maximum	0.12	0.26	0.65
	mean±SE	0.08 ± 0.02^{b}	0.19 ± 0.02^{b}	0.4 ± 0.06^{a}
Pb	Minimum	0.27	0.31	0.23
	Maximum	0.68	0.51	0.65
	mean±SE	0.45±0.07	0.42±0.04	0.51±0.08
As	Minimum	0.52	0.59	0.34
	Maximum	0.82	0.81	0.75
	mean±SE	0.74±0.06	0.69±0.04	0.64±0.08
Hg	Minimum	0.23	0.87	0.08
	Maximum	1.1	1.3	0.22
	mean±SE	0.59 ± 0.15^{b}	1.02 ± 0.08^{a}	0.15 ± 0.03^{c}

No.: Number of examined samples. SE: Standard Error of mean.
Means within the same row carrying different subscripted letter are significantly different ($p<0.05$) based on Duncan's multiple comparisons.

Higher concentrations of Pb can be observed in aquatic organisms due to anthropogenic sources. The mean concentrations level for lead residues in the examined *Claris gariepinus* from Abou Hammad, Zagazig and Faqous fish markets were 0.45±0.07, 0.42±0.04 and 0.51±0.08 ppm, respectively (Table 1). The highest concentrations of Pb were recorded in *Claris gariepinus* samples from Faqous fish market and the lowest concentration levels were in *Claris gariepinus* samples from Zagazig fish market and it was cleared that sampling area had no significant effect ($p<0.05$) on the lead levels in all the examined samples. This may be attributed to the equal distribution of lead sources from gasoline in all examined location. Shaltout *et al*. [22] recorded lower Pb concentrations in *Claris lazera* from Shebin El-kom, Menofia Governorate (0.14 ± 0.02 mg/ kg), 0.045 ± 0.002 ppm from different fish markets [21] and 0.19 to 0.29 from Rosetta branch, River Nile, Egypt [23]. However, higher lead residue levels (7.11, 7.48, 5.895, 6.72, 14.51, 14.10 mg/kg) were detected in catfish (*Clarias gariepinus*) from Aswan, Kena, Assiut, Beni-Suef, Damietta and Rosetta, respectively [20]**.** These differences in Pb concentration from other studies may be attributed to the variations in the environmental contaminations [24]. All the examined *Claris gariepinus* samples (100%) were higher than lead permissible limits of ES.NO.7136 [12] (0.1 mg/kg) (Table 2).

Table 2: Percentage of samples within or exceeding the maximum permissible limit of heavy metals in the examined *Claris gariepinus* samples collected from different fish markets at Sharkia Governorate.

Area	**Cd**		**Pb**		**As**		**Hg**	
	within PL	exceed PL	within PL	exceed PL	within PL	exceed PL	within PL	exceed PL
Abou Hammad	40	60	0	100	100	0	20	80
Zagazig	0	100	0	100	100	0	0	100
Faqous	0	100	0	100	100	0	100	0
PL.	0.05 [A]		0.1 [A]		1 [B]		0.2 [A]	

PL: Permissible Limit. , Cd: Cadmium, Pb: Lead, As: Arsenic, Hg: Mercury.
[A] Egyptian Standard (ES.7136) [12]. **[B]** The strictest international legislation in seafood (Munoz *et al.*) [33].

Arsenic is considered highly toxic metal even at very little concentrations. Marine organisms mainly fish can be contaminated by Arsenic from coastal regions known by industrial discharges commonly have high concentrations of toxic elements [25]. The inorganic forms of arsenic are categorised as carcinogens and the chronic exposure (10-40 µg daily) is concerned with skin, respiratory and bladder cancers [26]. The mean values in the examined *Claris gariepinus* from Abou Hammad, Zagazig and Faqous fish markets were 0.74±0.06, 0.69±0.04 and 0.64±0.08 ppm, respectively as showed in (Table 1). The Arsenic levels were in the order of Abou Hammad> Zagazig > Faqous fish market with no significant effect ($p<0.05$) on the arsenic levels in all the examined *Claris gariepinus* samples. The environmental contamination differences are the cause of this variation. Higher arsenic residues of 44.54 ± 5.69 and 1.23 ± 0.20 mg/ kg were recorded in fishes from Gwangju and Korea [27], while 1.01 ± 0.21 µg/g in *C. lazera* that collected from Bahr Albaker by El Ebidy [28] and 35.74 - 45.33 ppm in fresh water fish samples that were collected at Pakistan [29]. In Italy, Storelli and Marcotrigiano [30] found that the mean values of total arsenic ranged from 9.7 to 49.4 mg/kg wet weight in five fish species from the South Adriatic Sea and the toxic inorganic form percentage ranged from 0.47 to 3.48%. The fish contributed the greatest dietary exposure to population (94%) and had a mean arsenic concentration of 4.4 mg/kg wet weight in UK [31]. The difference in results may be attributed to the ability of fish to accumulate heavy metals depends on ecological needs, metabolism, degree of pollution in sediment, water and food [32]. In Egypt, no permissible limits have been recognized in fish for the arsenic concentrations. The total arsenic levels in all examined fish samples were lower than the maximum acceptable concentration (1 µg/g wet weight) suggested by the strictest international legislation in seafood [33].

Excessive exposure to mercury is associated with adverse health effects including damage to the kidney and the central nervous system (neurotoxicity) [34]. The mean Hg values of the examined *Claris gariepinus* from Abou Hammad, Zagazig and Faqous fish markets, respectively, were 0.59±0.15, 1.02±0.08 and 0.15±0.03 ppm (Table 1). The mercury concentration levels of examined *Claris gariepinus* were in the order of Zagazig > Abou Hammad> Faqous fish markets. These results were higher than 0.040 ± 0.001 ppm in Nile catfish from different fish markets [21] and 0.00087, 0.00017, 0.00067, 0.0012, 0.0046, 0.015 (mg/kg) in *Claris gariepinus* from Aswan, Kena, Assiut, Beni-Suef, Damietta, Rosetta, respectively [20]. The high levels of Hg reflect the increased use of mercury in agricultural and industrial activities in the studied area as fish has the ability to accumulate the residues of these toxic metals [35]. Nearly similar Hg level of Abou Hammad *Claris gariepinus* of 0.52 ± 0.04 mg/ kg were found by Shaltout *et al*. [22] in Shebin El-kom, Menofia governorate. It was cleared that sample location had a significant effect

($p<0.05$) on the mercury levels in the examined samples (Table 1). The Egyptian standards (ES.NO.7136) [12] is put an acceptable limit for mercury residues in meat, which must be, not exceed than 0.2 µg/g. According to this limit, 20% and 100% of the examined *Claris gariepinus* from Abou Hammad and Baher Albaker, respectively, were within the permissible limit and 100% of the examined *Claris gariepinus* from Zagazig fish market exceeded the permissible limit (Table 2).

Toxic metals in foods represent a consumer toxic hazard and depend on the concentration of the metal in food and the amount of consumed food [36]. The estimated daily intake (EDI) was calculated and presented in Table (3). The human's daily ingestion of arsenic usually indicates the arsenic quantities that occur in the diet of seafood at which arsenic present mostly in the organic form [37]. The ETDI in this study were 0.024, 0.27, 0.39 and 0.20 µg/kg BW for cadmium, copper, lead and total mercury daily consumption, respectively (Table 3). This estimated intake of heavy metals from consumption of the *Claris gariepinus* was within the recognized TDIs guidelines and considered to be safe for consumers.

Table 3: Estimated daily intake (EDI) µg/ kg body weight of different metals in comparison to the Tolerable daily intake (TDIs) µg/ kg body weight.

Samples		Cd	Pb	As	Hg
Abou Hammad	EDI (muscle)	0.04	0.25	0.40	0.32
Zagazig	EDI (muscle)	0.10	0.23	0.38	0.56
Faqous	EDI (muscle)	0.22	0.28	0.35	0.08
TDIs		1	3.57	2.14	0.57

As: Arsenic, Cd: Cadmium, Pb: Lead, Hg: Mercury.
EDI= (Cm x FIR)/BW, Cm = concentration of the heavy metal in the sample (mg/kg wet weight); FIR = (fish) ingestion rate 38.13 g/day) (FAO) [14], BW is the body weight = 70 kg.
TDIs according to FAO/WHO/ JECFA (Joint Expert Committee on Food Additives) [15]

Table 4: Target hazard quotient (THQ) and Hazard index (HI) of different metals from consumption of the examined samples collected from different fish markets at Sharkia Governorate.

Samples	THQ Cd	THQ Pb	THQ As	THQ Hg	HI
Abou Hammad	0.04	0.06	1.34	0.20	1.65
Zagazig	0.10	0.06	1.25	0.35	1.76
Faqous	0.22	0.07	1.16	0.05	1.50
RFD	0.001	0.004	0.0003	0.0016	

Cd: Cadmium, Pb: Lead, As: Arsenic, Hg: Mercury, THQ values may be estimated using the following equation:

$$THQ = \frac{EF \times ED \times FIR \times C}{RFD \times BW \times AT} x10^{-3}$$ Yi *et al.* [18].

THQ is the target hazard quotient; EF is exposure frequency (365 days/year); ED is the exposure duration (70 years, average lifetime); FIR is the food ingestion rate (g/day); C is the heavy metal concentration in meat (µg/g); RFD is the oral reference dose (mg/kg/ day); BW is the average adult body weight (70 kg); and AT is the averaging exposure time (365 days/ year × number of exposure years, assuming 70 years).
HI = HQ Cd + HQ Pb + HQ As + HQ Hg

The possible health risks of heavy metals in fishes must be estimated to assess the hazard risk on health of human and to establish the health levels that can solve the environmental daily life problems [38]. The THQ for Cd, Pb, As and Hg occur due to the consumption of *Claris gariepinus* from the three examined areas (Abou Hammad, Zagazig and Faqous fish markets) was tabulated in Table (4). The THQ ranged from 0.04 to 0.22 for cadmium, 1.16 to 1.34 for arsenic, 0.06 to 0.07 for lead and 0.05 to 0.35 for mercury. Although THQs of studied heavy metals did not exceed 1 through the consumption of fish, which theoretically demonstrating that human not acquires a major health hazard from the individual metals ingestion throughout consumption of *Claris gariepinus*. It was estimated that THQ of As due to *Claris gariepinus* consumption from the three areas was above one, reflecting a possible health risks for the consumers. This investigation is not completely true as arsenic present in food mainly in the organic form and small amount in the inorganic form (most toxic); however, the routine analytical methods regularly quantify the total arsenic [15]. In fish the inorganic arsenic mainly present in the less toxic form of organic arsenic by a percentage reaching 90% of total arsenic [39].

The risk contributions of Hg, Pb and Cd were low and did not increase above one. This finding was similar to Zohra and Habib [40] who estimated that the individual metal target quotients (THQ) due to fish consumption were decreased as the following: As > Hg > Cd > Pb, arsenic had the major risk of the total THQ and the next highest risk element was mercury.

Conclusion

The study shows that heavy metals of interest are still within safe limit for consumption. It can be concluded that the estimated dietary daily intakes of analyzed metals due to consumption of *Claris gariepinus* was within the suggested TDIs limit. The THQs of the all metals from *Claris gariepinus* utilization were lower than 1 except for arsenic (As) it was exceeds 1, demonstrating probable health risks, whereas. Finally, this work may offer valuable record for ongoing research on *Claris gariepinus* consumption in El Sharkia Governorate. It is recommended to improve aquaculture-fishing practice as well as permanent monitoring of *Claris gariepinus* is suggested to minimize the health risks for the consumers.

Conflict of interest

The authors have no conflict of interest to declare.

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الملخص العربي

تقييم مخاطر بعض المعادن الثقيلة من استهلاك سمك القرموط في محافظة الشرقية، جمهورية مصر العربية

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تهدف هذه الدراسة الي تحديد تركيزات بعض المعادن الثقيلة كالرصاص والكادميوم والزئبق والزرنيخ في سمك القرموط ولذلك تم تجميع ٩٠ عينه من أسواق أبو حماد والزقازيق وفاقوس بواقع ٣٠ عينه من كلا منها. تم نقل هذه العينات الي المعمل المركزي بكلية الطب البيطري بجامعة الزقازيق وذلك للكشف عن تركيزات هذه المعادن وتقييم مخاطرها على صحة الإنسان وتحديد المعدل اليومي لاستهلاكها، بالإضافة إلى تقييم المخاطر الصحية المحتملة والمرتبطة باستهلاك سمك القرموط. اوضحت النتائج أن متوسط تركيز الكادميوم ٠.٠٨ ± ٠.٠٢ و٠.١٩ ± ٠.٠٢ و٠.٤ ± ٠.٠٦. بينما متوسط تركيز الرصاص ٠.٤٥ ± ٠.٠٧ و٠.٤٢ ± ٠.٠٤ و٠.٥١ ± ٠.٠٨. فيما يتعلق بالزئبق، كانت القيم ٠.٥٩ ± ٠.١٥ و١.٠٢ ± ٠.٠٨ و٠.١٥ ± ٠.٠٣، بينما بلغ تركيز الزرنيخ ٠.٧٤ ± ٠.٠٦ و٠.٦٩ ± ٠.٠٤ و٠.٦٤ ± ٠.٠٨ جزء في المليون من منطقه العباسة والحلقة وبحر البقر على التوالي. أظهرت بعض عينات القرموط التي تم فحصها وجود تركيزات أعلى في بعض المعادن الثقيلة كالكادميوم والرصاص والزئبق والتي تتجاوز حدود السلامة الموصي بها في بعض المناطق والتي تم تحديد معاييرها في المواصفة المصرية. كانت معدلات الاستهلاك اليومي المقدر لكلا من الكادميوم والرصاص والزئبق والزرنيخ أقل من الكمية اليومية المسموح بها. بالإشارة إلى المخاطر الصحية المحتملة لسمك القرموط الذي تم فحصه. تم تقييم نسبة الخطر المستهدف من عنصر الزرنيخ لجميع عينات سمك القرموط من العباسة والحلقة وبحر البقر وكانت ١.٣٤ و١.٢٥ و١.١٦ على التوالي والتي تجاوزت ١ مما يمثل مخاطر صحية محتملة، في حين كانت هذه النسبة لعناصر الرصاص والكادميوم والزئبق في سمك القرموط من جميع المناطق التي تم فحصها أقل من ١ مقارنة بالجرعات المرجعية مما لا يمثل خطورة على المستهلك. علما بأن القواعد الصحية تنص على أن وجود اي ماده كيميائية حتى ولو لم تكن سامه فإنها تمثل خطر على صحة وسلامة الإنسان وعلى هذا فإن النتائج التي تم الحصول عليها تعطينا تنبيهاً بأن المستهلك يمكن أن يكون مهدد بمخاطر صحية. لذلك نوصي بتوعيه المستهلكين بمخاطر تلوث المياه بالنفايات بمختلف أنواعها والصرف الصحي ونفايات المصانع والحث على تركيب المرشحات البيولوجية ومنع الصيد في المياه الملوثة وذلك للحد من مخاطر المعادن الثقيلة في لحوم الاسماك كما نوصي بمزيد من التحقيق والبحث في اسماك القرموط النيلي في محافظة الشرقية.