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Full Length Article

Estimation of Lead and Cadmium residual levels in chicken giblets at retail markets in Ismailia city, Egypt

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Abstract Lead (Pb) and Cadmium (Cd) are environmental contaminants of food which have deleterious cumulative effect on human health. Using flame atomic absorption spectrometer (FAAS), the concentrations of Pb and Cd were estimated in 60 samples of chicken giblets comprising of broiler livers, gizzards and hearts collected randomly from retail markets in Ismailia city, Egypt. The greatest Pb concentrations were found in liver samples (0.8762 ± 0.2089 ppm), whereas gizzard samples contain 0.3186 ± 0.1462 ppm and lowest levels of Pb were detected in heart samples 0.1733 ± 0.06777 ppm. Cd deposited in liver samples reached 0.040714 ± 0.0290 ppm; however gizzard and heart samples contain negligible Cd concentrations (0.0041 ± 0.0028 and 0.0036 ± 0.008 ppm, respectively). These data interpreted that Pb residual concentration, particularly in chicken liver sold in Ismailia city, is more than the permissible limit (0.5 ppm) in the Codex Alimentarius international food standards and thus may be hazardous to human consumption and more serious inspection procedures should be applied by the veterinary authorities therein.

1. Introduction

Many food products are regularly tested for a selection of trace elements to estimate possible nutritional or toxicological associations and to warrant agreement with government regulations or food safety [1,2]. The level of an individual trace element varies significantly among the large diversity of foods but is generally consistent for a specific food product. Trace elements levels that may be considered safe or that satisfy a nutrient prerequisite may also be considered toxic at higher levels. The understanding of the total level of trace elements in food is essential for setting up dietary requirements; on the other hand, the concentration of the distinct element species in food is also required to estimate the food safety and nutritional quality [3].

The consumption of polluted food is the main source of Lead (Pb) and Cadmium (Cd) intake in the non-smoking population [4]. Pb is abundant in the environment from different

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sources include automotive gasoline piston engines, oil burners, lead pipes, incinerators, industrial effluents and smokestack fallout [5]. In humans, Pb affect different systems and causes neurological symptoms which can range from fatigue, headache, and lethargy to peripheral neuropathy, severe convulsions, encephalopathy, and even coma [4]. The direct neurotoxic actions of Pb include apoptosis, excitotoxicity. Also Pb has been associated with impaired neurobehavioral functioning in children, decrements in intelligence quotient [4].

Furthermore, low concentrations of Pb can be found in tissues of clinically normal birds and animals [6]. Broiler chickens are vulnerable to Pb intoxication. As tiny as 1.0 ppm Pb in the diet can cause significant growth suppression in chickens and consistent decline in blood D-aminolevulinic acid dehydratase, an erythrocyte enzyme sensitive to Pb [7]. Pb consumed by chickens is accumulated in bones, soft tissues, and eggs [7]. Pb bone levels are by far the uppermost, followed by kidney and liver. The lowermost Pb concentration is detected in skeletal muscle [8].

Anthropogenic Cd is a priority environmental pollutant and evolved health hazard [9]. The critical effect of long-term exposure to Cd is renal tubular dysfunction, which is irreversible; chronic renal failure is the final and severe endpoint. Cd is able to induce bone damage (Itai-ltai) [4]. Ecotoxicological researches displayed that sea-birds, which have their own breeding grounds in the arctic and subarctic regions of the northern hemisphere, have high levels of Cd which accumulates mainly in the kidneys at highest concentration and then in the liver at relatively lesser concentration. [10].

In poultry, ecotoxicological researches regarding Pb and Cd accumulation have been focused on the liver and kidneys because of their key role in the detoxification processes [10]. However, with reference to public health importance to these trace elements, it is essential to determine their concentrations in the principle of other edible giblet of chicken. Remarkably enough, Pb and Cd, in particular, concentrations in chicken giblets are infrequently explored. Thus, the aim of the current study was to estimate concentrations of Pb and Cd in chicken giblets particularly liver, gizzard and heart which are very popular in supermarkets and small grocery retail outlets in Ismailia city, Egypt.

2. Materials and methods

2.1. Samples collection

A total of 60 samples of chicken livers, gizzards and hearts (20 samples of each) were collected randomly from different retail markets all over Ismailia city, Egypt.

2.2. Samples homogenization and preparation of the analytical solutions

One hundred g of each sample was dried in an oven at 100 °C until constant weight was maintained. The dried samples were crushed with a porcelain mortar and pestle and kept in acid leached nylon bags in a desiccator prior to wet digestion [11]. Precisely, 2 g of each dried sample was added to 10 mL of the digestion mixture (3:2 65% v/v HNO_3 and 70% v/v $HClO_4$) [3,11]. The samples were digested by convection heating for 3 h in a water bath adjusted to 70 °C then the digest was allowed to cool and transferred into clean standard flask and de-ionized water was added to 20 mL. The solutions were transferred into acid-leached polyethylene bottles [11].

2.3. Estimation of Pb and Cd by flame atomic absorption spectrometer (FAAS)

Standard stock solutions of Pb and Cd (1000 ppm) were prepared and tenfold diluted to the corresponding expected mass fraction recovery of trace elements in the samples. Pb and Cd were analyzed by FAAS (Thermo-electron, S series GE 711838, Thermo Electron Corporation, Waltham, Massachusetts, U.S.A.). The wavelength of λ = 217 nm was used for detection of Pb while the wavelength of λ = 228.8 nm for Cd. Two replicate determinations were done for each sample. Sample blanks were prepared by taking 10 mL of the reagents mixture through the same procedure.

2.4. Statistical analysis

Data were expressed as mean ± standard error (SE) and analyzed using one way analysis of variance (ANOVA) followed by Duncan's test as a post-hoc test using IBM SPSS Statistics 22.0 software package and the chart was created by Microsoft Excel 2010 software.

3. Results and discussion

Pb and Cd are toxic metals occurring in the environment naturally and from anthropogenic activities and can lead to chemical contamination of products entering in the human food chain [4]. For assessing the threat to people posed by the presence of Pb and Cd in chicken giblets, FAAS analysis was employed on livers, gizzards and hearts samples sold at retail markets in Ismailia city, Egypt.

The minimum and maximum estimated concentrations of Pb were widely variable in livers, gizzards and hearts samples (Table 1). The significant utmost Pb concentrations were found in liver samples (0.8762 ± 0.2089 ppm), whereas gizzard samples contained 0.3186 ± 0.1462 ppm and the level of Pb was estimated 0.1733 ± 0.06777 ppm in heart samples (Fig. 1). The results of this study indicated that broiler livers samples contain high Pb levels which exceed the maximum limit (0.5 ppm) in the Codex Alimentarius international food standards [12].

This high level of Pb concentration could be attributed to the heavy environmental pollution with Pb which has high tendency for bioaccumulation in chicken tissue as it was deposited in kidneys (1.360 ppm), livers (0.500 ppm), ovarian tissue (0.320 ppm) and muscle (0.280 ppm) after experimental expo-

Table 1 Ranges of minimum and maximum Pb and Cd concentrations estimated in the examined samples of edible chicken giblets (ppm).

	Pb		Cd	
	Minimum	Maximum	Minimum	Maximum
Liver	0.1321	1.5107	0.0025	0.0765
Gizzard	0.1139	0.5176	0.0000	0.0211
Heart	0.0789	0.5770	0.0006	0.0071

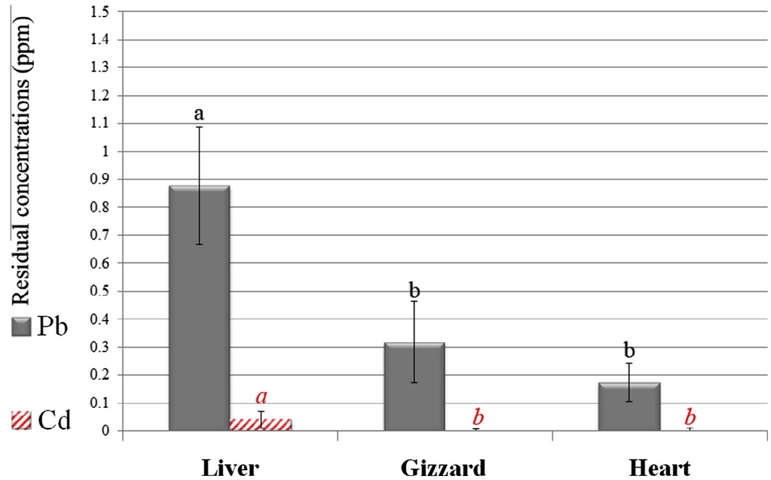

Figure 1 Comparison of means of Pb and Cd concentrations in examined samples of chicken livers, gizzards and hearts. Significant high Pb concentrations was found in liver, meanwhile no significant difference was detected in Pb concentration between gizzard and heart (regular black letters). Furthermore, Cd concentration of liver was significantly higher than of both heart and gizzard samples (*italic* red letters). Mean levels with similar letters were not significant. Data represent the means ± SE ($p < 0.05$). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

sure of chicken-folk to chips of lead-based paint in their environment for 9 days [13].

On the other hand, the minimum and maximum estimated concentrations of Cd were widely variable in liver samples; however Cd levels in gizzards and hearts showed narrow variation (Table 1). The mean Cd level (0.040714 ± 0.0290 ppm) deposited in the liver samples was significantly higher than Cd levels in gizzard and heart samples (0.0041 ± 0.0028 and 0.0036 ± 0.008 ppm, respectively) (Fig. 1). Fortunately, these results were far below the permissible limits for Cd in poultry liver, as the maximum allowable level of Cd in chicken liver in the Codex Alimentarius international food standards is 0.5 ppm [12].

An earlier study showed that the average Pb concentrations of the chicken meat samples was 0.006 ppm, meanwhile Cd residual content was lower than the limit of detection of the method employed in Finland [14]. Furthermore, mean concentrations of Pb and Cd were 0.00694 and 0.00168 ppm in chicken meat consumed by the population in Tenerife Island, Spain [15]. On the other hand, the contents of Pb and Cd in chicken granules and gourmet powder ranged from 0.0000 to 0.0092 ppm for Pb and from 0.0000 to 0.0037 ppm for Cd [16].

In Ismailia city, Egypt, the concentrations of Pb and Cd in many food samples were in the range of 0.0031–1.2 ppm and 0.001–0.321 ppm, respectively. Bread is the foodstuff that provided the highest rate of Pb and Cd (62% and 46% of the daily intake) to adults in Ismailia city [17]. The body burden of Pb and Cd depends mostly on the dietary intake of these elements [4]. Fortunately, the weekly estimated dietary intakes for Pb and Cd in Ismailia city, Egypt are 0.0204 and 0.00402 ppm body weight, respectively which still lower than the provisional tolerable weekly intake determined by FAO/WHO [17].

Since toxic Pb residues were found to be in high levels in the chicken livers, consistent surveillance and monitoring should be employed as its bioaccumulation could lead to serious human health problems among consumers. In addition, excessive consumption of livers originated from chicken raised in Pb contaminated environment should be discouraged. Furthermore, garlic could be advised to antagonize Pb toxicity, as garlic contains chelating compounds capable of enhancing elimination of Pb. Garlic feeding can be exploited to safeguard human consumers by minimizing Pb concentrations in chicken meat which had been grown in a Pb polluted environment [18].

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