INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES

IJPAES

Volume-5, Issue-2, April-June-2015 Coden: IJPAJX-USA, Copyrights@2015 ISSN-2231-4490

Received: 11th Feb-2015 Revised: 15th Mar-2015 Accepted: 17th Mar-2015

Research article

ASSESSMENT OF TRACE HEAVY METALS CONTENTS OF CHICKEN FROM ALGERIA

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ABSTRACT : Due to the consumption of chicken and chicken products(kidney, liver and meat) in Algeria at high ratio, The concentration of some heavy metals (Pb, Cd and Hg) content in chicken and chicken products collected from three major industrial and urban cities (Algiers, Bejaia, and Tizi ouzou) in Algeria were determined used atomic absorption spectrometry after acid digestion. The obtained results showed that the concentrations of the studied metals were under the recommended maximum acceptable levels proposed by the Joint FAO/WHO expert Committees. The levels of lead in some analyzed chicken products were higher than the recommended legal limits for human consumption. Trace element content in various parts of chicken samples and chicken products were to be found in kidney within the range of 42.05–122ug/Kg for mercury, from 17.77–19.55ug/kg for cadmium, and for 70.34–141.45g/Kg for lead. In liver within the range of 28.82–115ug/Kg for mercury, from 5.45–11.79 ug/kg for cadmium, and 103.85–128.56 ug/Kg for lead. In meat within the range of 25.5–99.11ug/Kg for mercury, from 4.69–10.53ug/kg for cadmium, and from 83.44–109.82ug/Kg for lead.
Key words*:* Trace element, heavy metals, Chicken, acid digestion, Atomic absorption spectroscopy

INTRODUCTION

Trace elements have positive and negative effects on both human health and the environment. Many researchers are interested in the analysis of the trace metal contents of the environmental samples and in particular food [1,2]. Accurate and adequate data of food composition are invaluable for assessing the adequacy of nutrients essential to assess risks of exposure to toxic consumption of heavy metals [3] Heavy metals can be classified as potentially toxic (cadmium, lead, mercury, aluminium, arsenic etc) and essential (iron, manganese, copper, zinc and selenium) [4,5]. Toxic elements can be very harmful even at low concentration when ingested over a long time period. The essential metals can also produce toxic effects when the metal intake is excessively elevated [6,7]. The ingestion of food is an obvious may of exposure to metals, not only because many metals are natural components of food, but also because of environmental contamination and also contamination during processing.

The levels of trace elements in chicken products and its various parts (kidneys, lever and meat) of the chicken samples have been widely reported in the literature [8,9]. However, the data on the levels of trace element in chicken samples and chicken products produced in Algeria are very limited. Due to their low-cost compared to red meat, chicken meat and chicken products are widely consumed in Algeria.

The aim of this study was the assessment of Fe, Pb, Cd and Hg concentrations in meat and meat products consumed in Algeria by flame and/or graphite furnace atomic absorption spectrometry after acid digestion. Moreover, the data was assessed by comparing estimations of dietary exposures with recommended dietary allowances (RDA) recommended by the World Health Organization [10]

Experimental

Samples

The study is carried on thirty (30) table fowl samples. The chicken samples were collected from three (03) different localities (Algiers, Tizi-Ouzou and Bejaia). The thirty (30) chickens in the long term (08 weeks), of an average weight of 2.5 kg were collected at the slaughter-house of Hammadi (Algiers). The sampling, spread out over the first quarter of the year, was made randomly.

The chicken products including kidney, liver, meat, samples were analyzed after acid digestion.

Reagents

All reagents were of analytical reagent grade unless otherwise stated. Double deionised water (was used for all dilutions, HNO_3 and H_2O_2were of supra pure quality (E. Merck, Darmstadt, Germany). All the plastic and glassware were cleaned by soaking in dilute HNO3 (1 + 9) and were rinsed with distilled water prior to use. The element standard solutions used for calibration were prepared by diluting stock solutions of 1000 mg/L of each element.

Apparatus

A PYE UNICAM SP9 (PHILLIPS) atomic absorption spectrometer (AAS) was provided with a kit for the cold vapor for the determination of mercury.

A Thermo Elemental SOLAAR 969 AA atomic absorption spectrometer (AAS) equipped with HGA graphite furnace and with deuterium background corrector was used in the experiments. For flame atomic absorption spectrometric measurements, a 10 cm long slot burner head, a lamp and an air-acetylene flame were used.

The reaction vessels were cleaned using a concentrated nitric acid before each digestion.

Acid digestion

Determination of mercury

The samples are digested in the presence of sulfuric acids, nitric acid and permanganate of potassium. The ions mercuric are reduced in elementary mercury by a stannous chloride solution ($SnCl_2$) and are brought then in gaseous form in a cell by bubbling of air. The mercury contained in the cell is determined by atomic absorption spectrometry with vapor formation [11]. The concentration of the sample is determined by comparison between the respective absorbance of the sample and those of a range of standard solutions. The standard solutions are prepared immediately before the analysis by atomic absorption spectrometry, in their adding 2ml of a solution of $SnCl_2$. For the parameters of the technique, the dosage is performed according to the operating mode absorbance and concentration calibration mode, the wave length were 253,7 nm.

Determination of Lead and Cadmium

The samples, analyzed by atomic absorption spectrophotometer equipped with a graphite furnace by the operating mode absorbance and concentration calibration mode, are submitted to the acid hydrolysis (concentrated hydrochloric and nitric acids). Released metals are then recovered using a nitric acid solution to 10 %. The dosage of Cd is carried out with a wave length of 228,8 nm and temperature programming: 100°C, 800 °C, 1200 °C and 2500°C. The dosage of Pb is carried out with a wave length of 217 nm and temperature programming: 100 °C, 300 °C, 900 °C and 2500°C.

Statistical analysis

The whole data were subjected to a statistical analysis One-way analysis of variance (ANOVA) was carried out to compare the means of different treatments, differences between individual means were tested using Tukey-HSD test at 0.05 or significant level. Student's t-test was employed to estimate the significance of values.

RESULTS AND DISCUSSION

In comparison with the consulted bibliography, few publications treated the contamination of chicken and chicken product by heavy metals. The most relevant concerned older animals considering the phenomenon of the chemical stability and the bio-accumulation of heavy metals. The obtained results reveal the contamination of some chicken and chicken product by the studied elements (Hg, Pb and Cd). The chicken meat frequently raised in building, having a relatively short life span (08 weeks), and few studies which have been concerned by this environmental contamination which generally accumulates during long years. The origin of this contamination could be therefore inherent to quality of water and food.

The concentration of investigated trace element in chicken samples were to be within kidney in the range of 42.05–122ug/Kg for mercury, from 17.77–19.55ug/kg for cadmium, and from 70.34–141.45g/Kg for lead. In the liver within the range of 28.82–115ug/Kg for mercury, 5.45–11.79ug/kg for cadmium, 103.85–128.56 ug/Kg for lead. In the meat within the range of 25.5–99.11ug/Kg for mercury, from 4.69–10.53ug/kg for cadmium, and from 83.44–109.82ug/Kg for lead.

The levels of Lead in some analyzed chicken products were higher than the recommended legal limits for human consumption.

According to these data, lead has the highest concentration in the studied samples and followed by mercury, and Cadmium.

Mercury is known to be toxic to many biological systems Mercury can cause neurological disorders, irritability, memory loss, insomnia, and gastro- intestinal disorders Mercury may penetrate in the food materials from food processing or environmental contamination [12]

Mercury highest and lowest levels found (25.5ug/Kg) in meat and 122.77ug/Kg found in kidneys. These values are fortunately below the permitted limit of 1.0 mg/kg [12] in the edible portion.

The results related to the contamination of the various matrices by Hg appear relatively high in particular in Algiers (Fig.1) but remain lower than the tolerance levels of the contamination fixed for fish by WHO (1990) [13], the JECFA (2003) [14] and the JOCE (2001) [15] (Residual Maximum Limit (RML) = 500 µg/kg of weight in a fresh state). These results join those of Korsrud GO et al, (1985) [15] which indicate that the levels of mercury in the three matrices studied in chicken are lower than the RML. This work related to the determination of the contents of the Arsenic, Cd, Pb and Hg in 650 samples of liver and kidneys of bovines and poultry for slaughter in Canada from 1979 to 1981 detected an average of Hg concentration at 0,25 µg/g at all the studied species. In this connection, Curley A et al. (1971) [16] report that the risk of poisoning by Hg at the man resulting from the ingestion of the red meats or the poultry is considered minimal except in rare cases where the animals feed by grains contaminated by this element. However, work of Boudene (1986) [17] indicates that the Hg value of the meats is generally lower than 5µg/kg, while the meat offals concentrate from 15 to 20µg/kg for the liver of the poultries and the bovines. Chavéron (1999) [18] reports that the organic shapes of Hg are in meat products at rates from 1to7 µg/kg. All these values are particularly low and require the consumption of consequent quantities of meats to reach the (permissible day amount and permissible weekly amount) (PDA and PWA).

The minimum and maximum lead content in the analyzed samples were found 83,44ug/Kg in meat and 128,56ug/Kg in liver. The levels of lead in some chicken products (meat, liver and kidney) were higher than the recommended legal limits for human consumption. The fact that toxic metals are present in high concentrations in chicken samples which are of particular importance in relation to the FAO/WHO (1976) [19] standards for Pb and Cd as toxic metals. The maximum permissible doses for an adult are 3mg Pb and 0.5mg Cd per week, but the recommended doses are only one-fifth of those quantities.

Lead is known to induce reduced cognitive development and intellectual performance in children and increased blood pressure and cardiovascular disease in adults [13].

the highest rates are recorded in the areas of Tizi-Ouzou and Bejaia in particular on the liver and kidneys matrix (Fig.2). Taking into account the environment of the three studied breedings located in an industrial park, the sources of exposure to Pb can be inherent to the air, water and/or the food. The presence of Pb in the consumed water is usually attributed to the phenomenon of corrosion of the piping and the structural components of the domestic distribution networks which contain Pb. [21, 22] The Provisional Tolerable Weekly Amount confirmed by the JECFA in 2000 [23] is 25 µg/kg of body weight, that to say the equivalent of 3,5 µg/kg of body weight per day.

The minimum and maximum cadmium contents of the samples were found 4.69ug/kg in meat samples and 19.55ug/kg in kidneys samples, respectively. Cadmium levels in chicken samples have been reported in the range of 0.05–0.09 mg/kg in Nigerian [8] 1–2ug/kg in Canada [24] Cadmium may accumulate in the human body and may induce kidney dysfunction, skeletal damage and reproductive deficiencies. The maximum cadmium level permitted for chicken samples is 0.5–1.0 mg/kg according to FAO/WHO (1976) [19] Cadmium levels in chicken products from different locality were lower than permitted levels.

The results of the contamination of chicken by Cd (fig. 3) show that this element is concentrated especially in the kidney without exceeding the LMR fixed by (JOCE, 2001) [15]. These results accord well with the work of Farmer (2000) [24] have focused on the determination of the concentrations of Zinc, of Cd and of Pb in food and the bodies of bovines, sheep, and horses, raised near a factory site in Eastern Kazakhstan rapported the a relationship between the concentration of different metals and the studied organs. The Cd concentrations are recorded in a descending order: kidney, liver, hairs, lungs, then muscle. on the other hand the work of Olsson et al. (2001) [26] bring back contents significantly lower levels of cadmium in the kidneys, the liver and the mammary gland of cows raised according to the biological mode of production. It clearly appears that the origin of the contamination in general of the animals by heavy metals would be attributed partly to an environmental contamination.

Our results illustrated in the (fig.4) show a relatively high Hg contamination in the locality of Algiers and a total contamination for Pb on the three areas. The breeding studied in area of Algiers is located at the Eucalyptus, it is separate only by the motorway of the garbage dump of Wadi Smar where there has been the daily combustion of domestic and industrial waste which entrains the emission of fume, ashes and fine particles on what can be adsorbed heavy metals and their oxides and sulfuric derivatives. The results of works of Yoshida et al. (2005) [27] bring back abnormally high rates of arsenic, chromium, copper, lead and cadmium as well in water as in the sediments of Wadi El-Harrach. The results of work of Lardji et al. (2005) [28] also revealed monthly average concentrations of nickel, of cadmium and of lead exceeding the guideline value proposed by WHO in the atmospheric aerosol of the municipal land fill of Wadi Smar. These studies have supported the probable origin of the contamination of chicken by the three metals at the locality of Algiers. The chicken samples of the area of Tizi-Ouzou also come from a farm located in an industrial zone, in the area of Wadi Aissi where there is concentration of various industries: textiles, accumulators of batteries, tanneries etc.

The same observation raised for the studied farm in the area of Bejaia established in an industrial zone where there is processing industries, accumulators and textiles. Moreover the commune of El-Kseur is located at about thirty kilometers of the commune of Tala-Hamza student known for its zinc and lead mining.

The obtained results reveal that the knowing of the mechanisms of transfer of heavy metals through the different parts of food chains proves to be capital in order to control more the pollution caused by these toxic elements. To protect the public health and also to maintain the specific characteristics of insuring safety and best quality.

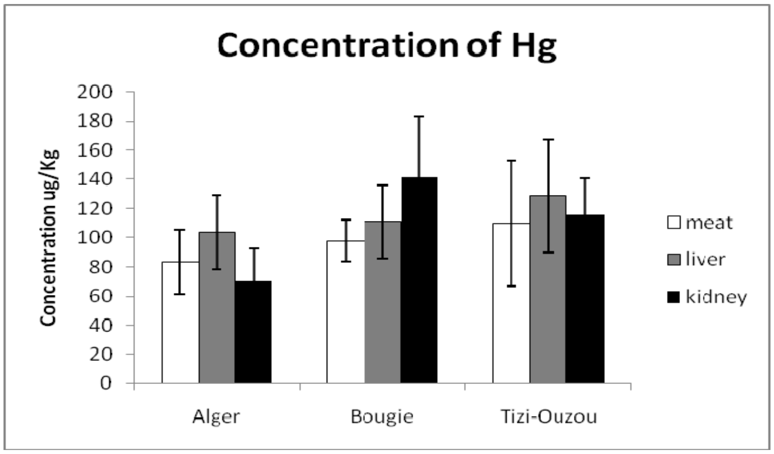

Fig. 1: Average contents of Hg in the various matrix by locality of breeding (M±SE) µg/kg.

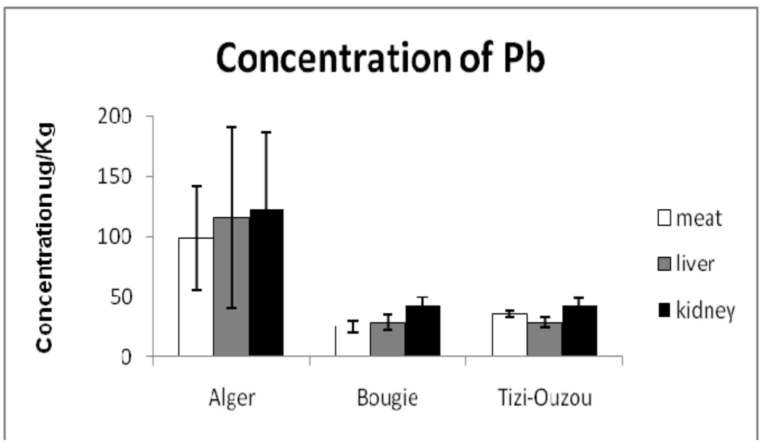

Fig. 2: Average contents of Pb in the various matrix by locality of breeding (M±SE) µg/kg.

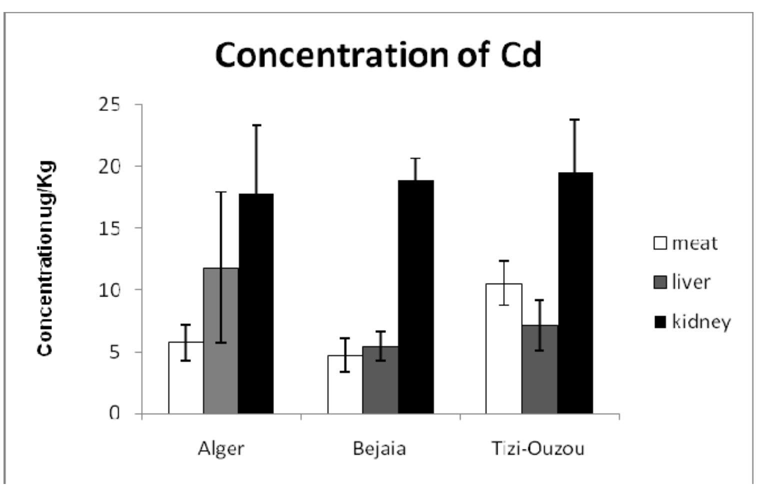

Fig. 3: Average contents of Cd in the various matrix by locality of breeding (M±SE) µg/kg.

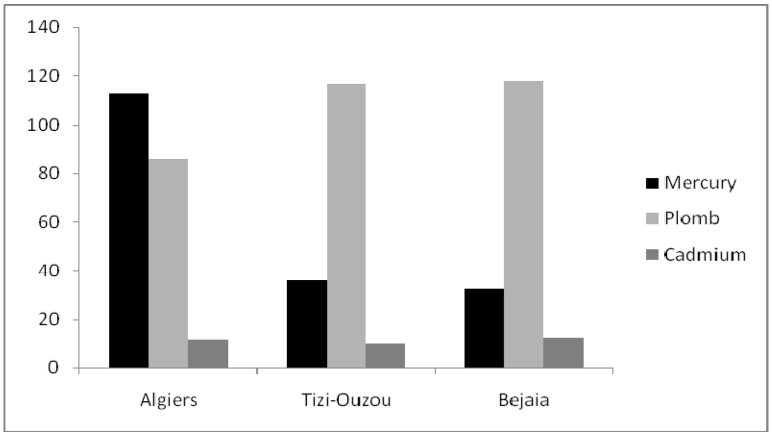

Fig.4: Average contents of Hg, Pb and Cd on the three localities studied in µg/Kg.

CONCLUSION

Our publication focuses on the assessment of the contamination of chicken meat by heavy metals (lead, cadmium and mercury) on the area centers Algeria (Algiers, Bejaia and Tizi-Ouzou). The choice of this area depends on the intensity of the industrial activities highly exposed to pollution concentrated in this zone strongly exposed to the various chemical pollutants.

The results obtained reveal a presence of heavy metals (lead, mercury and cadmium) in chicken meat, a perishable food of a very large consumption. They also permitted to highlight contamination of chicken by lead at a rate relatively high in the region of Tizi-Ouzou, and the presence of mercury at rate relatively high in the locality of Algiers compared to Tizi-Ouzou and Bejaia. As for level of the obtained, cadmium it is less than the RML on the three studied localities. In general, our study can be guided to find and identifier the sources of contamination and extended it to other food of an animal origin in order to take safety measurements to ensure that these strategic food products of a wide consumption are safe to be consumed.

ACKNOWLEDGMENTS

This work was supported by the Algerian Ministry of Higher Education and Scientific Research (MESRS), Algeria and by the Algerian Agency for the Development of Research in Health (ANDRS).
The authors are grateful for the director of Intendance Central Laboratory.

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INTERNATIONAL JOURNAL OF
PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES

ISSN 2231-4490

International Journal of
Plant, Animal and Environmental Sciences