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Detection of Heavy Metals and Radioactivity in Some Bones of Frozen Chicken Samples Collected from Libyan Markets

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Abstract
The contents of some heavy metals and radioactivity were measured in some bones of frozen chicken samples collected from Libyan markets. The obtained results showed high levels of heavy metal were lower than the reference doses recommended by USEPA (U.S. Environmental Protection Agency) and JECFA (Joint FAO/WHO Expert Committee on Food Additives).

Keywords: Metals, Radioactivity, Frozen Chicken, Libya

Introduction
Food safety is a major public concern worldwide. During the last decades, the increasing demand of food safety has stimulated research regarding the risk associated with consumption of food stuffs contaminated by pesticides, heavy metals and/or toxins.
The implication associated with heavy metal contamination is of great concern. Heavy metals, in general are not biodegradable, having long biological half-lives and having the potential for accumulation in the different body organs leading to unwanted side effects. These metals can pose a significant health risk to humans, particularly in elevated concentrations above the very low body requirements (Duruibe *et al*., 2007) [7].
The risk associated with the exposure to heavy metals present in food product had aroused widespread concern in human health. Improvements in the food production and processing technology had increased the chances of contamination of food with various environmental pollutants, especially heavy metals (Abduljaleel *et al*, 2012) [1].
Ingestion of these contaminants by animals causes deposition of residues in meat. Hence contamination with heavy metals is a serious threat because of their toxicity, bioaccumulation and biomagnifications in the food chain. Although contamination of animal feed by toxic metals cannot be entirely avoided given the prevalence of these pollutants in the environment, there is a clear need for such contamination to be minimized, with the aim of reducing both direct effects on animal health and indirect effects on human health (Abduljale *et al*., 2012) [1].

Heavy Metals
Heavy metal contamination is of worldwide concern due to food safety issues and human health risk through the food chain. Once contaminated with metals, soils can be a potential source of contamination for plants and animals for a long time. Several studies have focused on the transfer of heavy metals from soil to animals either by direct contamination or via vegetation. Heavy metals may accumulate in the vegetation, posing a risk for animals and humans, although soil is a biochemically active filter for most metals. Previous toxicological investigations on bovines, poultry, etc. have shown a direct correlation between metal concentrations found in animal feed and in animal tissues. Thus, information about heavy metal concentrations in animals through the food chain is important for assessing their risks to human health (Demirezen and Urue, 2006) [5].
Avian species such as birds and ducks are susceptible to bioaccumulation of pollutants mainly through the consumption of contaminated food. For the higher trophic level of the food web, chickens can serve as a useful bio indicator species for environmental monitoring. Concentrations of environmental contaminants in tissues of chickens can be used to evaluate chronic or acute exposure, as chickens are fed a wide variety of feed stocks. The metal accumulations in chickens via contaminated diets have been investigated in a few studies to assess the potential human risk from poultry consumption. Contamination by heavy metals has recently major international concerns due to the industrial revolution.
Regional and local levels of heavy metals have influences on the functional and structural integrity of an ecosystem

(Abduljaleel *et al*., 2012) [1]. Agricultural enterprises of farmers which involve had increasingly complaining inadequate health requirement due to susceptibility of their birds to environmental anthropogenic activities and air pollution (Schwartz, 1994) [17].

The latter leads to precipitation of these pollutants inside animal stocks which are consumed directly by human beings indirectly within the food chain. Accordingly, the risk associated with exposure to heavy metals present in food product had led to a wide spread con health. The concentration of heavy metals in tissues of chicken has been extensively studied *et al.,* 2012; Hamasalim and Mohammad, 2013; Hassanin *et al*., 2014) [10, 11].

Bioaccumulation of heavy metals in the tissues of poultry has generated public health concerns due to the lethal and sub accumulation in the food chain (Burger Some heavy metals alert potentially toxic effects arsenic, cadmium and lead as well as trace elements such as iron, manganese, copper, zinc, selenium and cobalt (Duruibe *et al.*, 2007) [7]. levels in chicken and other domestic bird scanty.

Bioaccumulation of heavy metals in tissues of bird has lately received some sub-lethal effect of their accumulation convenience use of the food chain in bioaccumulation studies (Burger *et al.*, 1994) [2]. Chicken meat is a valuable food source rich in many essential nutrients e.g., various proteins, fats and vitamin D. The concentrations of the heavy metals vary amongst avian species pending on various factors and have been detected in various body.

Radioactivity

We living in a period in which there is tremendous expansion in the use of atomic energy. There is great interest in possible hazards to man of the radioactivity associated with the release of the energy of the atom. Of considerable concern is the contamination of man's environment with radioactive materials. Such materials added to the atmosphere, soil, and natural waters may be taken in by man and levels of radioactivity may be built up in the body sufficient to be damaging. In the environment radioactive contaminants may accumulate in different tissues and affect their utilization or availability (El- Reefy *et al*., 2010) [9].

In discussing radioactive materials, we need to consider that these materials are radioactive isotopes of chemical elements. In most cases the atoms that compose a chemical element differ in mass and those of like mass members, the isotopes, are present in definite ratios (El Zakla, 2013) [8].

For instance, carbon, wherever it is found in nature, is composed almost 99 per cent of carbon atoms of mass number 12 and about one per cent of carbon atoms of mass number 13. With the advent of man-made isotopes of carbon with other mass numbers, for example carbon-14, which is radioactive, it is possible to have carbon com-pounds in which the isotopic ratio is changed by inclusion of radioactive atoms (Krmar, 2009) [14].

For the most part, the chemical and physiological processes of the body make use of elements to form compounds without discrimination as to their isotopic composition. Thus, a radioisotope may be incorporated into the body tissues of marine plants and animals if present in their environment (Degerlier *et al*, 2008) [4].

Living tissues accumulate chemical elements to different degrees. It is well known that certain elements, such as calcium and strontium, are concentrated in skeletal structures, such as bone and shell. Other elements are present in greater amounts in certain soft tissues and organs (Schuiling 1985) [16].

Although maximum levels of concentration of an element exist, the elements composing the compounds of the body are constantly being replaced. Some compounds are broken down and reformed rapidly; others only slowly (Dugalic *et al*., 2010) [6]. If radioactive isotopes are included with the other isotopes of the element involved in the metabolism of organisms, an accumulation of radioactivity can result (He and Walling, 1996) [12].

Annual Effective Dose Rate (AEDR)

The annual effective dose rate (AEDR) in mSv y^{-1} resulting from the absorbed dose values (*D*R) was calculated using the following formula (General Assembly with Annex B, United Nations, New York, 2000).

$$\text{Ann. Eff. dose rate } (\text{mSvy}^{-1}) = \text{DR } (\text{nGyh}^{-1}) \times 8760 \text{ hy}^{-1} \times 0.7 \times (103 \text{ mSv}/ 109 \text{ nG y}) \times 0.2$$

Activity Utilization Index (AUI)

In order to facilitate the calculation of dose rates in air from different combinations of the three radio nuclides in foods and by applying the appropriate conversion factors, an activity utilization index (AUI) is constructed that is given by the following expression (Venema, and De Meijer, 2001) [18].

$$\mathbf{AUI} = (\text{AU}/ 50 \text{ Bq kg}^{-1}) \text{ f U} + (\text{A Th} / 50 \text{ Bq kg}^{-1}) \text{ f Th} + (\text{AK} / 500 \text{ Bq kg}^{-1}) \text{ f K}$$

Where *A* (Th), (*A*U and *A*K) are activity concentrations (in Bq kg^{-1}) of 232Th, 238U and 40K and *f* Th(0.604), *f* U(0.462) and *f* K(0.041) are the fractional contributions to the total dose rate in air due to gamma radiation from the actual concentrations of these radio nuclides.

Radiation Hazard Indices

The two other indices that represent external and internal radiation hazards (Ligero *et al*., 2001) [15]. The external and internal hazard index is obtained from Raeq expression through the supposition that its allowed maximum value (equal to unity) corresponds to the upper limit of Raeq (370 Bq kg^{-1}). The external hazard index (*H*ex) and internal hazard index (*H*in) can then be defined as.

$$\text{Hex} = (\text{AU} / 370 \text{ Bq kg}^{-1}) + (\text{ATh} / 259 \text{ Bq kg}^{-1}) + (\text{A K}/ 4810 \text{ Bq kg}^{-1})$$

$$\text{Hin} = (\text{AU}/185 \text{ Bq kg}^{-1}) + (\text{ATh}/259 \text{ Bq kg}^{-1}) + (\text{AK}/4810 \text{ Bq kg}^{-1})$$

Where *A*U, *A*Th, and *A*K are the activity concentrations of 238U, 232Th and 40K respectively. This index value must be less than unity in order to keep the radiation hazard to be insignificant (Cho *et al*, 1996) [3].

Radiation in Food

Every food has some small amount of radioactivity in. The common radio nuclides in food are potassium 40 (^{40}K), radium 226 (^{226}Ra) and uranium 238 (^{238}U) and the associated progeny. Here is a table of some of the common foods and their levels of ^{40}K and ^{226}Ra. Th Natural Radioactivity in Food may be summarized in the following Table.

Natural Radioactivity in Food

Table 1: Natural Radioactivity in Food

Food	^{40}K (pCi/kg)	^{226}Ra (pCi/kg)
Banana	3,520	1
Brazil Nuts	5,600	1,000-7,000
Carrot	3,400	0.6-2
White Potatoes	3,400	1-2.5
Beer	390	---
Red Meat	3,000	0.5
Lima Bean raw	4,640	2-5
Drinking water	---	0-0.17

This study was carried out on some frozen chicken samples which collected from local markets at El–Beida city Libya. The main aim of this study is to determination of some heavy metals including (pb, Co, Cd and Cu) and measuring the radioactivity residual in bones of the selected samples

Experimental Part
Samples Collection
A total of Five samples of different frozen chicken parts were randomly collected from commercial local markets in El -Baida city. This experiment was therefore designed to verify the intensity of heavy metal accumulation in them. The types of the collected chicken samples were shown in Table 1.

Table 1: The samples of the studied frozen chicken

Samples	Sample Name	Source
1	NAT	Brazil
2	Aot Al -Soltan	Libya
3	Griller Chicken	France
4	Al -Resha	Turkish
5	Frangilosol	Brazil

Samples Preparation
Only 0.5 gm±0.1 sample of each sample was weighed up using a sensitive balance. The bones of each sample was separated, then dried at dry place, the samples were grounded in mortar, Then derided again in an oven at 70°C for 24 hrs.

Heavy Metal Analysis
The samples were designed by nitric acid until near dryness, the residual filtered and then the valium completed to 100 ml in measuring flask. The heavy (Lead, Cobalt, Cadmium and Copper) contents were determined by atomic absorption, the contents were expressed as µg/g.

Radioactivity Analysis
The radioactivity values were measured according to Giger account after the elimination the radioactivity of the around media at the physics department, Faculty of Science, Omar El–Mukhtar University. The values of radioactivity were expressed as Bq/Sec.

Results and Discussion
The Results
Heavy Metals
The contents of the studied heavy metals are shown in Table 2 and Fig 1. The results recorded that, the concentrations of heavy metals (Lead, Cobalt and Copper were ranged as following, (7.58-8.50 µg/g), (6.90-15.0 µg/ g) and (0.93–1.61 µg/g), respectively, where the high contents were related to cobalt (Co) and ranged between (6.90-15.00 µg/g), the higher value of was recorded in (sample No. 4). Also, the study recorded that all the selected samples not contain cadmium.

Table 2: The contents of heavy metals of the studied chicken samples

Samples	Pb	Cd	Co	Cu
1	8.50	-	8.75	0.93
2	8.43	-	7.87	1.21
3	8.36	-	7.09	1.38
4	7.58	-	15.00	1.42
5	8.26	-	6.90	1.61
Average	8.22	-	9.12	1.31
± SD	0.371	-	3.36	0.25

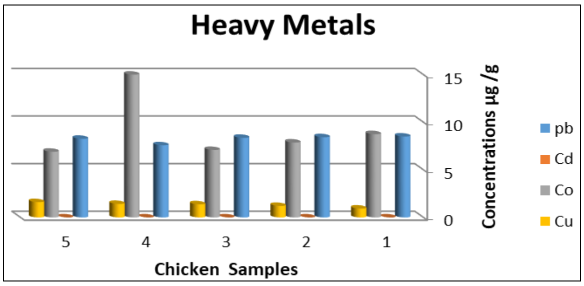

Fig 1: The distribution of heavy metals of the chicken samples (µg /g)

Radioactivity
According to the radioactivity values which recorded in the studied, there is relative variation between the studied samples. The radioactivity contents were ranged between (0.0033-.040 Bq/Sec), the values of radioactivity of the samples were given as following:

(0.0267, 0.0033, 0.0067, 0.0333 and 0.040 Bq/Sec) for the samples 1, 2, 3, 4 and 5, respectively. The content was recorded in (Giriller chicken), whereas the lower content was recorded in the sample of (Frangiosole), Table 3 and Fig 2.

Table 3: The radioactivity residual values of the studied chicken

Samples	N1	N2	N	$N-N_0$	Activity (Bq /Sec)
1	65	61	63	8	0.0267
2	55	57	56	1	0.003
3	58	56	57	2	0.0067
4	64	66	65	10	0.0333
5	66	68	67	12	0.040

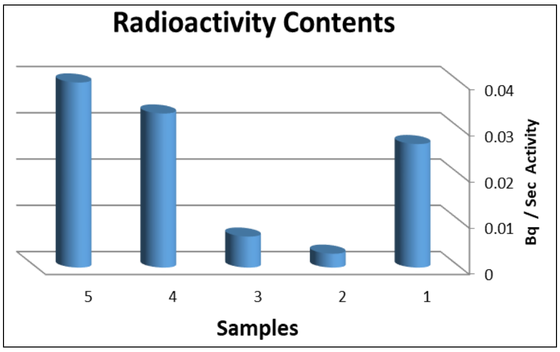

Fig 2: The distribution of radioactivity values of the studied frozen Chicken samples

Discussion

Generally, the average annual indoor effective dose from terrestrial radio nuclides is 0.46 Bq/sec (UNSCEAR), Therefore, the obtained values from this study (0.04 Bq /Sec) is lower than the world average value.

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