

Original Research Article

Heavy metal residues in frozen chicken meat consumed within Erbil province

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Abstract

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To evaluate the quality of frozen chicken imported to Iraq the heavy metal residues of six metals e.g. Iron (Fe), Manganese (Mn), Magnesium (Mg), Calcium (Ca), Zink (Zn) and Lead (Pb) in ppm were determined in three different body parts i.e. breast, wing and thighs of Brazilian and Turkish origins. These heavy metals were determined using X-ray fluorescence spectrometer (XRF). The contents were compared with the internationally allowed limits for the safety purposes. While Fe, Mn, Mg, Ca were within the limit, the Zn and Pb have exceed the internationally allowed limits by WHO in Brazilian chicken. Both wing and thigh muscles, especially in Brazilian revealed higher proportion of Zn than permissible limits (10-50 ppm) allowed by ANZFA in comparison with other breast tissues. It is concluded that Turkish chicken meat might be safer than the Brazilian chicken. Public are encouraged to consume national chicken rather than the imported ones which might be polluted by heavy metals originated from industrially raised poultry products.

Keywords: Chicken meat, Health risk, Heavy metals, Pollution

INTRODUCTION

Contamination by heavy metals has recently become a 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). Poultry within agricultural enterprises of farmers which involve flocks had increasingly complaining inadequate health requirement due to susceptibility of their birds to environmental anthropogenic activities and air pollution (Schwartz, 1994). The latter leads to consequent precipitation of these pollutants inside animal stocks which are consumed directly by human beings or and indirectly within the food chain. Accordingly, the risk associated with exposure to heavy metals present in food product had led to a wide spread concern in human health.

The concentration of heavy metals in the internal tissues of chicken has been extensively studied (Hussain *et al.*, 2012; Hamasalim and Mohammad, 2013; Hassanin

et al., 2014). Bioaccumulation of heavy metals in the tissues of poultry has generated public health concerns due to the lethal and sub-lethal effects of their accumulation in the food chain (Burger *et al.*, 1994). Some heavy metals alert potentially toxic effects i.e. arsenic, cadmium and lead as well as trace elements such as iron, manganese, copper, zinc, selenium, nickel and cobalt (Duruibe *et al.*, 2007). Data on trace element levels in chicken and other domestic birds in Iraq are still scanty. Bioaccumulation of heavy metals in tissues of bird has lately received some attention upon lethal and sub-lethal effect of their accumulation a part from the convenience use of the food chain in bioaccumulation studies (Burger *et al.*, 1994).

Chicken meat is a valuable food source rich in many essential nutrients e.g. various proteins, fats and vitamin-D (Schonfeldt and Gibson, 2008). The concentrations of the heavy metals vary amongst avian species pending on various factors and have been detected in various body

Table 1. The arithmetic means and St. deviation (\pm Sd) of six heavy metals [Iron (Fe^{+3}), Manganese (Mn^{+2}), Magnesium (Mg^{+2}), Calcium (Ca^{+2}), Zink (Zn^{+2}) and Lead (Pb^{+2})] as ppm detected in different parts of two imported frozen chicken muscles (Brazilian and Turkish). International Permissible Limits (IPL); (*): Significant ($p \leq 0.05$); (**) $p \leq 0.01$.

Metals	Origin	Breast	Wing	Thigh
Fe	Brazilian	0.09 \pm 0.00	0.09 \pm 0.00	0.09 \pm 0.00
	Turkey	0.09 \pm 0.00	0.09 \pm 0.00	0.09 \pm 0.00
Mn	Brazilian	37.08 \pm 2.52	28.17 \pm 2.27*	39.68 \pm 2.39
	Turkey	38.96 \pm 3.24	43.12 \pm 4.53	44.60 \pm 3.03
IPL		6.5		
Mg	Brazilian	0.02 \pm 0.00	0.06 \pm 0.03	0.02 \pm 0.00
	Turkey	0.02 \pm 0.00	0.03 \pm 0.00	0.02 \pm 0.00
Ca	Brazilian	1.66 \pm 0.03*	1.78 \pm 0.05	1.58 \pm 0.04
	Turkey	1.64 \pm 0.04*	1.64 \pm 0.04*	1.54 \pm 0.05*
Zn	Brazilian	32.19 \pm 4.65	88.27 \pm 9.91	131.27 \pm 24.01*
	Turkey	30.30 \pm 5.79	86.13 \pm 10.71	47.73 \pm 4.61
IPL		10-50		
Pb	Brazilian	0.44 \pm 0.03	0.84 \pm 0.06*	0.43 \pm 0.02
	Turkey	0.39 \pm 0.01	0.63 \pm 0.02	0.42 \pm 0.02
IPL		1		

parts including, blood, skin, lungs and feathers in various proportions (Abduljaleel *et al.*, 2012). Given the prevalence of these pollutants in the environment contamination of animal to toxic metals cannot entirely be avoided however, their minimization becomes so necessary to reduce both direct effects on animal health and indirect effects on human health (Scan, 2003). Apart from red meats, chicken meat is a major source of protein to the public all over Iraqi cities. The objectives of this research have been to determine the concentration and distribution of some heavy metals i.e. Fe^{+3} , Mn^{+} , Mg^{+2} , Zn^{+2} , Ca^{+2} and Pb^{+2} in different tissues e.g. breast, wing and thigh in some imported frozen chicken meat from Brazil and Turkey.

MATERIALS AND METHODS

Samples collection

A total of ninety samples of different frozen chicken parts were randomly collected from commercial local markets in Erbil city. Two different origin-imported chicken meats were chosen i.e. Brazilian and Turkish chicken parts (45 samples each), included 15 wings, 15 breasts and 15 thigh parts from each group were collected during the period of May to August 2015. These three parts of chicken are regularly consumed by public as separate upon their taste. This experiment was therefore designed to verify the intensity of heavy metal accumulation in them.

Samples preparation

Only 10 gm \pm 0.2 sample of each part were weighed up using a sensitive balance, put in an oven at 70°C for 24

hrs then grounded to powder using a mortar. Two gram of each was used for elements analysis.

Samples analysis for elements

The residues of Fe, Mn, Mg, Zn, Ca, and Pb were determined using X-ray fluorescence spectrometer, Skyray 9000, portable XRF device (XRF). These heavy metals are so popular elements assessed in most other studies. The diagnosed period has been limited to only 100 seconds. The X-ray fluorescence spectrometry, as an instrumental analytical method is capable to determine elemental composition of solid and fluid samples from minimally prepared sample size. Additionally this method can be used for direct analysis for both solid and liquid materials. The samples were shot by the X-ray to excite the atoms within the sample so that a typical characteristic radiation for particular elements is emitted. Energy (wavelength) of these characteristic radiations does change element by element. This fact is considered as the bottom line of the qualitative element analysis. The intensity of characteristic radiation of each element would be measurable to its concentration which permits the qualitative analysis. Data were analysed statically using the readymade statically program SAS (2002-2003) system to study the means of heavy metals residues in two different origins (Turkish and Brazilian) imported meat parts taken from breast, wing and thigh. The Duncan multiple range test (1955) was used to compare the differences between the means.

RESULTS

Except for magnesium, the mean concentration of six different heavy metals in Brazilian was significantly higher ($p \leq 0.05$) than the Turkish chicken (Table 1). The proport-

ion of Fe^+ appeared same in all three parts of chicken breast, wing and thighs in both Turkish and Brazilian chicken meat. Proportion of Mn^+ , however, appeared significantly higher ($p \leq 0.05$ – ≤ 0.01) in wings of Turkish 43.12 ± 4.53 than in Brazilians 28.17 ± 2.27 and significantly higher than the international permissible amount (Fig. 2). Means of magnesium and calcium ions appeared similar in both Brazilian and Turkish chickens and in all three parts of the body. While Zn^{+2} proportions appeared similar in both types of chickens appeared three folds over and significantly higher ($p \leq 0.01$) in Brazilians than in Turkish. Surprisingly, the lead appeared significantly higher ($p < 0.05$), particularly in the wings, in Turkish meat than in Brazilians but below the international permissible level (Table 1).

DISCUSSION

The concentration of heavy metals in liver and chicken meat products has been determined by several authors and in different countries (Kirkpatrick and coffin, 2006; Santhi *et al.*, 2008; Blanco-Penedo *et al.*, 2009). Despite enough production of local chicken in Iraq, public interest is directed towards consumption of imported chicken, contrary to alive national chicken, is easy and ready to cook. Upon public survey carried out in Kerkuk province, the local chicken meat is proved to be tastier than imported foreign chickens. The favourable taste of national chicken might be due to their consumption to residues of rich public foods than readymade diets on which the imported poultry do feed (Bazzaz *et al.*, 2015, unpublished data).

Pollution of poultry with heavy metals is an inevitable worldwide phenomenon particularly in industrial countries. Residues of the pollutants are detected in several parts of avian including feathers (Abduljaleel *et al.*, 2012). Heavy metals are considered to be persistent types of pollutant which cannot be destroyed by heat treatment, to which extent their potential is enhanced to reach and effect, in the food cycle, the human being (Levensend and Barnard, 1988). The proportion of Fe^+ in all tissues of both origin (Brazilian and Turkish) were similar and lesser than permissible hygiene limits. Iron tends to accumulate in high level as Fe^{+3} from surrounding environment. The iron ion widely contributes to the molecular structure in redox system form of heme-proteins and non heme-enzymes as it has been reported to be so important as an essential element in all living organisms from invertebrates to human (Kanakaraju *et al.*, 2008). Therefore, the lesser iron ion proportion than the international amount in these imported chicken meats is poorer and questionable in comparison with red meat (Pennington *et al.*, 1998).

International records have taken into account all parts of the chicken meats as a whole rather than in parts. Differences in the proportion of these heavy metals in

these three parts were detectable. They may reflect different deposition intensity in them or due to the less amount of muscle meat in the wings than in breast and thighs. This may also indicate the safety of consumption of breast and thighs meat than wings. Nevertheless, the proportion of Mn was significantly higher than permissible limits in all chicken muscles 6.5 ppm according to Becking and Chen (1998). However, the mean concentration of Mn in Turkish chicken wings showed exception as it was significantly higher in comparison with Brazilians. This might be interpreted as a higher proportion of Mn existed in diet consumed by Turkish chicken. However, this point may need further investigation to explore the exact reason. Although the consumer dietary exposure of Mn are 67ug/kg body weight for adults, 101 ug/Kg body weight for young people (FSIS, 2004) the daily intake of small or trace amounts of Mn is necessary for both growth and good health in human, otherwise deficiency of Mn can cause nervous system problems (Dermirezen and Uruc, 2006).

There are no permissible limits of Ca and Na in beef mutton and poultry which are important intracellular cation which acts a second messenger in various signal transduction cascades (Irfana *et al.*, 2004). Generally, Both Mg^+ and Ca^{+2} ions in Turkish and Brazilian chickens are considered as electrolytes which retain useful for the body (WHO/FAW) showed low proportions (0.02 and 1.6 ppm, respectively). The Mg is considered to be one of the seven essential macro-minerals required as much as or greater than 100mg/day. The human body contains approximately 20-28 mg of Magnesium in which over 50% of is stored in the system and the rest is found in muscle, soft tissues and bodily fluids (Krause, 2008). Despite known importance however, no interpretation could be concluded in the current study.

Trace Zn can cause problems e.g. too much Zn is harmful to human health as it represents the intestinal irritant present in environment (ATSDR, 2004). The significantly highest ($p \leq 0.05$) Zn concentration was detected in both Brazilian and Turkish frozen chicken muscles especially in thighs and above the permissible level (ANZFA, 2001). However, in the Brazilian chicken it was significantly higher than the Turkish i.e. in wing and thigh muscles. No interpretation is clear at this stage for such differences however, genus or/and species differences are not ignorable. These result however are in concomitant with a most recent work (Hamasalim and Mohammad, 2013) and is consistent with that of Demirbas, (1999); Sari *et al.*, (2008); Abduljaleel *et al.*, (2012).

Lead is known to induce reduced cognitive development and intellectual performance in children and increase blood pressure and cardiovascular disease in adults (Commission of the European, 2002). The source of lead contamination of food livestock come from the air, water, food materials, cooking utensils and food packaging. Lead concentrations appear to be within

permissible limit in both Brazilian and Turkish chicken [0.5-1 ppm] (Young, 2005) which indicates their safety for public consumption. The liver tissue was not included in the present study however it would seem important source of protein to be considered in the future studies as it represents one of import favourite part consumed by public in Iraq.

While camel's meat maintained the lowest values of most studied heavy metals in comparison with other products in Saudi i.e. fishes which was attributed to the polluted air of both Eastern and middle of the kingdom as the industrial activities are highest (Alturiqi and Albedair, 2012). This indicates the source of pollution in the exported countries which could play an important role in deposition of these heavy and trace elements in their live stocks. Therefore, recommendation is made to encourage consumption of local national meats despite their preparation hassles in cooking for Iraqi women and restaurants.

CONCLUSION

It is concluded that Turkish chicken meat might be safer than the Brazilian chicken. Public are encouraged to consume national chicken rather than the imported ones which might be polluted by heavy metals originated from industrially raised poultry products.

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