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ESSENTIAL AND TOXIC METALS DETERMINATION IN IMPORTED AND FRESH BEEF CATTLE MEAT SOLD IN ERBIL MARKETS

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ABSTRACT

Meat of cattle (beef) constitutes a greater percentage of red meat in human diets because of its nutritive value and palatability. However, it can be contaminated with heavy metals just like other food materials. Heavy metals are very harmful due to their ability to accumulate in human body. Thus, this examination is completed to decide the heavy metals levels in frozen beef cattle meat obtained from different markets and fresh meat collected randomly from local beef cattle (Iraqi) and imported beef cattle (Brahman) at slaughterhouse in Erbil city. The result showed that the concentrations of most studied heavy metals were found to be significantly higher in imported frozen boneless beef cattle meat than those of fresh boneless meat obtained from local and imported cattle. The results also reveal that the concentrations nickel and lead metals in imported frozen cattle beef meat surpassed as far as possible set by Food and Agricultural Organization. The burden of the body with these components is extremely reliant on the concentration of the different components in main sources of animal protein, namely meat obtained from cattle. Therefore, people that consume imported beef cattle meat are probably going to be presented to higher nickel and lead concentrations and might be harmful to the health.

Contribution/Originality: This study is one of the very few studies which have investigated the concentration of some essential and toxic metals in imported and local cattle meat sold in the markets of Erbil city, with emphasis on hygienic and toxicological aspects.

1. INTRODUCTION

Meat from beef cattle is one of the essential sources of red meat in human food that is perceived as lean meat with high biological value (Al-Zuhairi, Farhan, & Ahemd, 2015). Beef cattle meat is gaining preference by many meat consumers, thanks to its low intramuscular fat, mainly saturated fatty acid, and cholesterol level when contrasted with comparative cuts of mutton (Pighin et al., 2016). Regardless of its low in fats content when contrasted with meat from different ruminants, beef cattle meat has a high extent of unsaturated fatty acids notwithstanding being a source of conjugated linoleic corrosive, which have such useful consequences for human wellbeing as mitigating, hostile to thrombotic and atherosclerotic deterrents (Daley, Amber, Patrick, Glenn, & Stephanie, 2010). Moreover, beef cattle meat is likewise a source of niacin, vitamins B6 and B12, phosphorous, zinc, and iron. Aside from meat framing an essential portion of the food we eat, it may carry certain toxic substance which is one of the sources of heavy metals for humans (Fathy, Ali, Schwagele, & Abd-El-Wahab, 2011). In meat, toxic substances are caused by a number of sources including veterinary medicines, animal feed or drinking water,

agricultural chemicals and industrial chemicals (Fathy et al., 2011). The occurrence of contamination of meat and its products with heavy metals during processing have additionally been informed (Harlia & Balia, 2010). Since the contamination with heavy metals is poisonous quality, bio-magnification, and bioaccumulation in the evolved way of life, it is a serious risk to human health (Demirezen & Uruç, 2006). Besides, meat tainting with heavy metals is worry for both human wellbeing and food security since these metals at minute levels are natural toxicity (Santhi, Balakrishnan, Kalaikannan, & Radhakrishnan, 2008). In the last few years, much attention has been focused on the concentration's heavy metals of chicken meat as well as processed product of chicken meat with little information regarding the content of metals in meat of beef cattle. In the Erbil governorate, meat of beef cattle is a main source of protein to the population and is largely consumed. To the best of our knowledge, there is a dearth of information regarding the content of metals in meat tissues of beef cattle in Erbil city. Hence, study was conducted in order to determine the concentration of some essential and toxic metals in imported and local cattle meat, with emphasis on hygienic and toxicological aspects.

2. MATERIAL AND METHODS

2.1. Sample Collection

The current study was carried out between the periods of September 2017 to December 2017. Meat samples of different types of beef cattle were collected and divided into imported frozen boneless beef meat of Ukraine origin were bought from different markets, fresh boneless meat was collected randomly from local beef (Iraqi cattle) and imported beef (Brahman cattle) at slaughterhouse in Erbil governorate, Iraq. All samples were collected in polyethylene bags as per their category, transported to the lab and stored at -20 ºC until subsequent analyses.

2.2. Samples Treatment and Analysis

From each collected meat sample, ten grams were dried in an oven at 100 ºC and ground into a fine powder using a ceramic mortar for heavy metals evaluation. The amounts of essential (Fe, *Co*, *Cu* and Zn) and toxic metals *(*Hg, *Ni*, Pb and As*)* were determined using X-ray fluorescence spectrometer (Genius 9000 XRF, USA) according to procedure described by Chelebi, Bazzaz, Yakub, Bazzaz, and Hammad (2015). The final results were expressed in milligram of metal per kilogram of dry meat

2.3. Statistical Analysis

One way analysis of variance (ANOVA) was applied to analysis data using the General Liner Model procedure of Statistical Analysis System (SAS Institute Inc., Cary, NC, USA) package Version 9.2 software. Significant levels at $p<0.05$ were carried out to assess whether means of the studied heavy metals varied significantly between frozen boneless beef cattle meat groups using Duncan's multiple range test. Data obtained for essential and toxic metals were presented as mean ± standard error.

3. RESULTS AND DISCUSSION

The concentrations of essential metals in the different cattle meat samples are presented in Table 1. Iron (Fe) and Zinc (Zn) have the highest concentration in the three meat samples as compared to the other elements. The imported frozen boneless beef meat contained significantly high concentration of Fe (131.210 mg/kg meat) than fresh boneless meat from imported cattle (120.500 mg/kg meat) and local cattle (120.400 mg/kg meat). The high value of iron could be due to the amount of blood retained in meat which is determined by the slaughter method. Blood contains a high amount of hemoglobin. Hemoglobin is comprised of four polypeptide chains with each chain containing one haem group; gathering; every haem comprises of an iron iota composed inside the porphyrin ring (Sabow et al., 2016). The poisonous quality of iron is represented by retention. The more you take in the more you are in danger. The iron is caught up in the ferrous state by cells of the intestinal mucous. Gastric and intestinal

emissions can diminish ferric particles (the unusable type of the iron) to the ferrous (absorbable) state. Ferritin is a one of a kind iron stockpiling protein containing 24 stockpiling proteins. At the point when overabundance dietary iron is assimilated, the body delivers more ferritin. Ferritin is significantly inexhaustible in the heart and liver, consequently there is an expansive sum in these organs, and iron hurries to these organs for capacity. The body can just deliver such an extensive amount these proteins; notwithstanding, so abundance press develops in these organs and causes tissue devastation (Aljaff, Rasheed, & Salh, 2014). In current study, iron in all samples fell within the recommended tolerable levels by FAO/WHO (2011). Significant differences were observed in the concentration of Zn and the imported frozen boneless cattle meat and fresh boneless meat from imported cattle had the highest values (47.100 and 48.825 mg/kg meat) than the fresh boneless meat from local cattle (31.942 mg/kg meat). The values of zinc in all investigated samples were lower than the maximum zinc level allowed by FAO/WHO (2011) for red meat (50 mg/kg). Zinc element plays a vital role in human diet. Taking excessively zinc is destructive to human wellbeing. According to Badis, Rachid, and Esma (2014) ordinary groupings of zinc in meat samples was 35 - 45 mg/day, so it gives the idea that most researched tests in the present examination contained elevated amounts of zinc. Nonetheless, our outcome for zinc was like those recorded by López Alonso et al. (2000) and Miranda, López-Alonso, Castillo, Hernádez, and Benedito (2005). These authors stated that muscles of cattle are the tissues where zinc is most likely to accumulate. The values of Cobalt (Co) in all samples of meat were not as much as allowable point of confinement (3 mg/kg). Cobalt is an essential trace mineral for human body because it is an essential component of vitamin B_{12}. This vitamin is important for making red blood cells (Akan, Abdulrahman, Sodipo, & Chiroma, 2010). Copper is an essential nutrient for the human body as it helps maintain healthy bones, blood vessels, nerves and immune function as well as it contributes to iron absorption (Lee & Stuebing, 1990). In this study, the imported frozen boneless beef cattle meat had significantly higher copper concentration (15.416 mg/kg meat) compared with fresh boneless beef cattle meat from imported cattle (3.068 mg/kg meat) and the fresh boneless beef cattle meat from local cattle (1.502 mg/kg meat). However, the concentration of copper in studied meat samples was below the permissible limit of 40 mg/kg (FAO/WHO, 2011).

Table-1. Concentrations of essential metals in various meat samples sold in Erbil markets.

Metal concentration (mg/kg dry weight)	Samples			
	Fresh boneless beef meat (Iraqi cattle/local)	Fresh boneless beef meat (Brahman cattle/imported)	Imported frozen boneless beef meat (Ukraine)	IPL
Iron	120.400 ± 0.300^{b}	120.500 ± 0.386^{b}	131.210 ± 0.0250^{a}	140
Cobalt	1.063 ± 0.025	1.089 ± 0.022	1.082 ± 0.006	1
Copper	1.502 ± 0.087^{b}	3.068 ± 1.040^{b}	15.416 ± 0.960^{a}	40
Zinc	31.942 ± 2.546^{b}	48.825 ± 7.208^{a}	47.100 ± 3.397^{a}	50

Note: ^{a,b} Means in the same row with different letters are significantly different at $p<0.05$.
IPL - International Permissible Limits.
Values are means ± standard error.

Concentration of toxic metals in various cattle meat samples available in markets of Erbil city are shown in Table 2. The concentration of nickel (Ni) in the imported frozen boneless cattle meat, fresh boneless meat from local and imported cattle ranged between 6.191, 0.204, and 0.276 mg/kg meat, the highest Ni concentration was observed in the imported frozen boneless beef cattle meat. The appropriate amount of nickel in human body is responsible for regulation of prolactin and stabilization of RNA and DNA structures, but at very high concentrations it can be negatively effect on human health (Chowdhury et al., 2011). Ni concentrations obtained from imported frozen and fresh beef cattle meat in this study were higher than the permitted mercury limit of 0.2 mg/kg (FAO/WHO, 2011). The high concentrations of nickel could be due to the increased use of nickel in industrial and agricultural activities in the areas that meat or animals were imported from them. Mercury was

detected at concentrations ranging between 0.014 and 0.019 mg/kg meat for the three studied samples and none of the samples exceeded the recommended limit of 1.0 mg/kg (FAO/WHO, 2011). The level of lead in studied meat samples was present in the range of 0.486 to 0.723 mg/kg. The highest value of lead was detected in imported frozen boneless beef cattle meat while the lowest concentration was detected in local and imported fresh beef cattle meat. Additionally, this study indicated that lead concentrations for imported frozen meat were above the recommended limits of 0.5 mg/kg set by FAO/WHO (2011). Lead is one of the major toxic heavy metals and can be affected children's brain development resulting in reduced intelligence performance as well as increased blood pressure and cardiovascular disease in adults (Yakupa, Sabowa, Saleh, & Mohammed, 2018). The obtained results showed that the arsenic (As) contents of meat samples ranged between 1.498 and 1.763 mg/kg. The lowest arsenic value recorded in local fresh beef cattle meat, while the highest concentrations were found in imported fresh boneless beef cattle meat. However, the obtained results for arsenic were lower than the standard permissible levels, 2.0 mg/kg (FAO/WHO, 2011). The International Agency for Research on Cancer has classified arsenic and arsenic compounds as carcinogenic to humans (Nkansah & Ansah, 2014).

Table-2. Concentrations of toxic metals in various meat samples sold in Erbil markets.

Metal concentration (mg/kg dry weight)	Samples			
	Fresh boneless beef meat (Iraqi cattle/local)	Fresh boneless beef meat (Brahman cattle/imported)	Imported frozen boneless beef meat (Ukraine)	IPL
Nickel	0.204 ± 0.095[b]	0.276 ± 0.017[b]	6.191 ± 0.117[a]	0.2
Mercury	0.014 ± 0.004	0.019 ± 0.004	0.017 ± 0.001	1.0
Lead	0.486 ± 0.008[b]	0.496 ± 0.064[b]	0.723 ± 0.030[a]	0.5
Arsenic	1.498 ± 0.052	1.763 ± 0.076	1.623 ± 0.045	2.0

Note: [a,b] Means in the same row with different letters are significantly different at $p<0.05$.
IPL - International Permissible Limits.
Values are means ± standard error.

4. CONCLUSION

The present findings indicate that heavy metals namely, iron, cobalt, *copper*, *zinc*, *nickel*, mercury, lead and arsenic were detected in all the samples analyzed. Among the eight heavy metals measured, the value of *nickel* and lead was observed in significantly high levels in imported frozen boneless cattle beef meat that exceeded the tolerance limit. Therefore, the utilization of meat in which metal levels beyond the tolerated dose were detected may be hurtful to the consumers' health, measurements beneath as far as possible, however not destructive, might posture health hazard when eaten in huge amounts because of bioaccumulation.

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