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Estimation of the heavy metal concentration in the poultry meat being produced in Kasur

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Key words: Bioaccumulation, Heavy Metals, Kasur, Permissible Limits, Poultry Meat.

Abstract

Poultry meat forms a vital part of the daily di *et al.*, over the world. However, the poultry meat is not always as healthy as it seems; it is also being affected by environmental pollution, especially heavy metals which have the potential to bioaccumulate and biomagnify and hence pose a potential hazard to human health. The present study was carried out to assess the contamination of poultry meat. Different meat samples, including 11 samples of chicken heart, 6 samples of chicken kidney and 12 samples of leg tissue, wing tissue, leg bone, wing bone, backbone, ribcage and neck bone each were collected from the Kasur city which is seriously polluted due to tanning industry. All the samples were analysed for heavy metals (arsenic, cadmium, copper, chromium, mercury, iron, lead, manganese, nickel and zinc) via the Inductively Coupled Plasma- Spectrophotometer. When compared with the reference standards stipulated by the WHO and EU, cadmium and lead exceeded the reference standards in all the chicken meat, liver and bones samples. Lead and mercury also exceeded the limit set by ANZFA. All the meat samples were under the permissible limit set for arsenic, copper and zinc by ANZFA and for chromium set by EU. Manganese exceeded the permissible limit set by WHO in only wing bone and backbone while nickel was high in all chicken parts than the tolerable level set by WHO.

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Introduction

Meat is the most widely consumed source of proteins and fats including many essential metals (Demirezen and Uruç, 2006; Khurshid and Qureshi, 1984). A total of 314.7 million tonnes of meat was produced globally in 2014 out of which, poultry meat accounted for 110.2 million tonnes (Food and Agriculture Organization, 2015). Chicken is a commonly consumed protein source around the world owing to its relatively lower cost and superior nutritional value in comparison with beef and mutton. In Pakistan also, Poultry meat constitutes an important source of food. As of year 2014-2015, 28.0% of the total meat production in Pakistan is contributed by its poultry industry, with an annual growth rate of 8-10% and around Rs. 200 billion is being currently invested in the industry (The Ministry of Finance, 2015). The Lahore division has 2060 poultry farms, out of which 590 are in the Kasur district, making it the second largest poultry contributor of the region (Poultry Research Institute, 2014).

Uncontrolled industrialization and widespread urbanization has resulted in escalated pollution of the environment, especially in developing countries. The pollutants enter the environment through vehicular emissions, release of industrial effluent and dumping of solid waste. The contaminants released enter humans through the food chain. One important category of environmental pollutants is heavy metals. These heavy metals like mercury, lead, cadmium, arsenic, copper, chromium, nickel, manganese, zinc, iron etc also enter the environment through natural phenomenon albeit in much lower concentrations than from anthropogenic sources (Duffus, 1980; Hunt, 1996; Osuji and Onajake, 2004). Though some of these elements (like zinc, copper, chromium, iron, manganese, nickel etc) are essential, in minute quantities, for carrying out numerous physiological functions, many like arsenic, cadmium, lead and mercury are toxic to the human body when they exceed the required levels . Moreover, they biomagnify and bioaccumulate in the food chain and enter the food chain at the primary level i.e. the fruits, vegetables and fodder crops via contaminated soil and water and also from deposition from vehicular emissions from where they build up in the tissues of the primary and secondary consumers (Food Safety Authority of Ireland, 2009; Demirezen and Uruç, 2006; Khurshid and Qureshi, 1984; Zhangu *et al.,* 2009, Sharma and Agrawal, 2009). Heavy metals exposure has also been linked to cancer (Mates *et al.*, 2010; Ionescu *et al.*, 2006; Liu *et al.*, 2013; Tchounwou *et al.*, 2012).

Numerous studies from around the world corroborate the presence of heavy metals in meat mainly due to consumption of contaminated feed by animals and the polluted environment they are kept in (John and Jeanne, 1994; Miranda *et al.*, 2005; Sharif *et al.*, 2005; Junka *et al.*, 2006; Lawal *et al.*, 2006; Sabir *et al.*, 2003; Koréneková *et al.*, 2002; Horky *et al.*, 1998; Rudy, 2009; Smith *et al.*, 2010; Poti *et al.*, 2010; Szkoda *et al.*, 2013; Hanan *et al.*, 2012; Sthanadar *et al.*, 2013; Tabinda *et al.*, 2013;).

Environmental pollution in Kasur is prevalent due to the industrial activity; primarily leather tanneries (Afzal *et al.*, 2014; Shakir *et al.*, 2012; Qazi *et al.*, 2010, Tariq *et al.*, 2007; Thomsen, 2008). Solid waste from tanneries is also utilised in formulating the poultry feeds. Sunda (2010) determined the chromium levels which bioaccumulated in the flesh part of the chicken from its feed via solid waste from the tanneries. Similarly, Hossain *et al.* (2007) carried out a comparative study in a leather tannery intensive area called Hazaribagh Thana in the south-west of the city of Dhaka. An earlier study on metal contamination has demonstrated the presence of heavy metals in poultry feed from samples obtained from poultry farms in Kasur (Imran *et al., 2014*).

Studies carried out in Pakistan and elsewhere have shown that poultry feed and meat easily gets contaminated with heavy metals from various environmental sources. Shah *et al.* (2010) found mercury concentration in the leg, breast, liver and heart samples taken from four poultry farms in

Hyderabad, Karachi. Sabir *et al.* (2003) also analysed some heavy and essential metals (Pb, Cu, Ni, Zn, Ca, Mg and Fe) in sixteen meat samples of fish. Beef, mutton and chicken bought from local market and from four spots along the Nullah in the Azad Kashmir area. Whereas, Khalil (2010) found out that apart from copper and zinc, the concentration of lead, nickel and chromium was above the recommended levels set by WHO, ANZFA and European Commission, in chicken leg and wing samples obtained from three different markets of Peshawar. Mahmud *et al.* (2011) estimated the levels of Cr (VI) in the leg, arm, head, heart, liver and bones i.e. chest cage, head, neck, leg and wing of the chicken samples obtained from local vendors in the Garden Town market of Lahore. Mariam *et al.* (2004) concluded that the high levels of heavy metals in the liver, kidney and lean meat of beef, mutton and poultry samples collected from different markets of Lahore vouched for the increasing levels of environmental pollution.

Since chicken is a much widely consumed source of meat in Pakistan, it has the greatest potential to result in heavy metal toxicity. This study was carried out with the purpose of determining the concentration of selected heavy metals in the poultry lean meat, bones and tissue samples collected from Kasur; the second largest poultry meat contributor to the Lahore city.

Materials and methods

Sample Collection

The sampling for this study was carried out in May and June. Fig. 1 shows the location of 12 separate vendors in the city of Kasur, Pakistan from where a total of 113 meat and bones samples were randomly collected. There were 6 kidney samples, 11 heart samples, 12 liver samples and 12 samples each; of wing and leg muscles and leg, wing, backbone, rib cage and neck bone. The meat and bones samples were immediately placed into contamination free, clean plastic bags that had been washed with deionized water prior to sample collection.

Sample Preparation

Nitric Acid (HNO_3) analytical grade (69 % purity) and Deionized water reagents were used for sample preparation. All the funnels, beakers, volumetric flasks, pipettes and glass rods utilized during the course of this study were of the company Pyrex while the model of electronic balance used was UX3200 G which was of the company Shinadzu Corporation Japan.

Fig. 1. Poultry Meat Sampling Locations; Source (District Profile Kasur, 2001).

Key.

Sample	Location
1	Sardar Dewan Road, Kasur
2	Lahore Road, Kasur
3	Qadaiwind Road, Near Jamia Masjid, Kasur
4	Circular Road, Kasur
5	Other shop; Sardar Dewan Road
6	Haji Chicken Sale Center, Lahore Road, Kasur
7	Pervaiz Chicken Shop, College Road, Kasur
8	Mangal Mandi Road, Kasur
9	Fazul-ur-Rehman, Kot Fateh Abad, Kasur
10	other shop; Qaidaiwind Road
11	Ali Chicken Center, Muslim League Chok, Kasur
12	Gora Bhatta, Kasur

Mineralization of all the lean meat, tissues and bones was done by following the standard wet digestion method with concentrated nitric acid (Alarcon *et al.*, 1996). Each sample was weighed and 0.25g of each sample was placed into a beaker. Then, 5ml of nitric acid was added in order to dissolve the sample. The solution was then transferred into a volumetric flask and its volume was made up to 100ml by using the deionized water. Whatman filter paper was used to filter the solution which was then poured into clean glass sampling bottles which had already been prewashed with deionized water. The prepared sample solutions were then analysed for heavy metals.

Analysis of Heavy Metals

Heavy metals; arsenic, cadmium, copper, chromium, iron, lead, mercury, manganese, nickel and zinc were determined using the Perkin-Elmer Optima DV 5300 model of ICP-MS (Inductively Coupled Plasma- Mass Spectrometer).

Internal standards were prepared by making a 2L solution containing 500 µg/L 6Li, 20 µg/L Rh, and 10 µg/L Ir after performing serial dilutions of commercial aqueous standards using 1% HNO_3 (nitric acid). The sample to be analyzed was mixed in a 1:1 ratio with the standard using a dual channel peristaltic pump equipped with a mixing manifold and coil. 5 commercially available multi-element calibration standard solutions in conjunction with one USGS-WRD standard reference sample were used to calibrate the ICP-MS.

Results and discussion

The result of the analysis of ten heavy metals in samples obtained from 12 different locations are given in Table 1 while Table 2 represents the permissible limits as set by different regulating authorities while, the Fig. 2 to Fig. 11 depict the mean concentration of each heavy metal in a specific meat part, as percentage, relative to other meat parts.

Table 1. Mean Concentration of Heavy Metals in all Samples.

Metals	Mean Concentration (ppm) ± Standard Deviation									
	Heart	Liver	Kidney	L. Tissue	W. Tissue	L. Bone	W. bone	Back-bone	Neck	Rib-cage
As	0.24±0.27	0.30±0.25	0.77±0.68	0.59±0.58	0.16±0.33	0.10±0.09	0.15±0.08	0.22±0.12	0.19±0.61	0.13±0.14
Cd	0.45±0.06	0.50±0.04	0.40±0.10	0.35±0.16	0.30±0.13	0.39±0.18	0.40±0.20	0.41±0.13	0.44±0.19	0.39±0.19
Cr	0.30±0.20	0.82±0.19	0.86±0.17	0.76±0.24	0.59±0.15	0.53±0.14	0.43±0.13	0.64±0.25	0.64±0.25	0.37±0.18
Cu	3.01±0.59	2.78±0.72	2.23±0.45	2.38±0.15	2.45±0.43	2.96±0.55	2.86±0.60	2.6±0.37	2.83±0.64	3.11±0.39
Fe	78.46±8.18	75.99±5.31	72.73±8.58	77.07±11.26	75.82±6.45	76.87±9.52	71.91±14.10	64.43±13.36	79.85±6.65	86.73±9.43
Hg	0.16±0.10	0.09±0.07	0.18±0.11	0.18±0.11	0.11±0.07	0.08±0.11	0.10±0.14	0.10±0.10	0.13±0.08	0.17±0.09
Pb	2.25±0.55	2.29±0.38	2.42±0.33	2.35±0.50	2.55±0.70	2.41±0.81	1.67±0.63	1.76±0.67	1.88±0.70	1.47±0.69
Ni	3.49±0.78	3.88±0.73	3.00±0.57	2.78±0.66	2.95±0.51	2.90±0.72	2.70±0.40	2.76±0.67	3.14±0.48	3.15±0.37
Mn	0.29±0.14	0.37±0.21	0.41±0.14	0.42±0.09	0.40±0.09	0.48±0.18	0.58±0.13	0.59±0.12	0.42±0.17	0.26±0.11
Zn	33.02±6.00	31.89±6.13	33.42±5.29	30.93±2.97	31.97±5.76	32.53±7.96	34.26±6.61	29.57±5.92	34.0±13.14	29.81±9.70

The results showed that the overall highest mean concentration was of iron in all the samples collectively followed by zinc while the lowest overall mean concentration was of mercury. The highest mean concentration of arsenic (As) was found in the kidney at 0.77±0.68 ppm while the lowest was 0.10±0.09 ppm in the leg bone. Arsenic concentrations in all the meat parts were under the permissible limit of 2.0 ppm set by ANZFA (Australia New Zealand Food Authority). The arsenic levels determined in this study were much lower with the one carried out by Mariam *et al.* (2004) (46.77±5.33 ppm) on broiler chicken samples obtained from Lahore. A recent study on groundwater quality in Lahore has also shown presence of arsenic in Lahore's ground water (Hamid *et al.*, 2013). Arsenic might be present in the meat due to it being a constituent of the broiler feeds being formulated from either fishmeal having a high arsenic content or crops of feed ingredients that had been sprayed with arsenic containing insecticides and weedicides e.g. roxarsone, arsanillic acid, nitrarsone etc. Acute exposure to arsenic causes nausea, headache and severe gastrointestinal irritation (Allan *et al.*, 1995). Inorganic arsenic is the most potent human carcinogen (Roy and Saha, 2002). Chronic arsenic exposure causes inflammatory, degenerative and neoplastic changes of cardiovascular, haematopoetic, respiratory, nervous system (Neiger and Osweiler, 1989) and re productive system (Waalkes *et al.*, 2003).

Table 2. Maximum Tolerance Limits of Heavy Metals in Poultry Meat.

Heavy Metals	EU (ppm)	ANZFA (ppm)	FAO/WHO(ppm)
Arsenic	-	2.0	-
Lead	0.1	1.0	0.1
Mercury	1.0	0.03	-
Cadmium	0.05	-	0.05
Chromium	1.0	-	-
Copper	-	200	-
Zinc	-	150	-
Manganese	-	-	0.5
Iron	-	-	-
Nickel	-	-	0.5

Cadmium's (Cd) maximum and minimum concentration were 0.50±0.04 ppm in the liver and 0.30±0.13 ppm in the wing tissue respectively. Its mean concentrations exceeded the permissible limit (0.05 ppm in lean meat and bones) set by both EU (European Union) and WHO (World Health Organization) in all such samples while liver reached the maximum level of 0.5 ppm for liver tissue given by EU and WHO. Mean cadmium level in kidney tissue was below the permissible limit of 1.0 ppm established by EU and WHO. The quantity of cadmium was also determined in the poultry meat and liver by Mariam *et al.* (2004) but was less in meat and more in liver than the ones found in this study. The cadmium levels were higher in almost all the samples than the ones documented by both Iwegbue *et al.* (2008) and by Oforka *et al.* (2012) whereas, Skalicka *et al.* (2002) reported lower Cadmium concentrations.

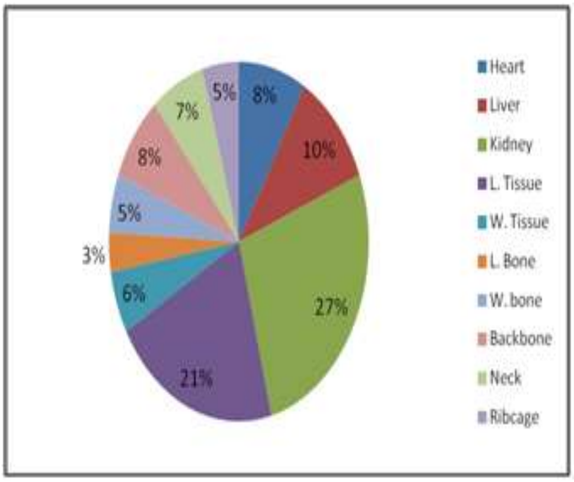

Fig. 2. Comparison of Mean Concentration of As in Different Parts of Poultry Meat.

However, the cadmium concentration documented in the present study were similar to the one found out by

Akan *et al.* (2010). The presence of cadmium can be attributed to tannery effluent as on average, a tannery releases 0.160 mg/l of cadmium in its wastewater (Tariq, 2009). One of the major sources of cadmium is food (Baykov *et al.*, 1996) and high levels of cadmium cause renal dysfunction, lung damage, hypertension (John *et al.*, 1994), bone demineralization and endocrine disruption (Lafuente *et al.*, 2004). It can also cross the placenta and affect the liver and kidneys of the foetus (Reddy and Yellamma, 2006). Different doses of cadmium stimulate or inhibit immune activity (Kosanovic *et al.*, 2002).

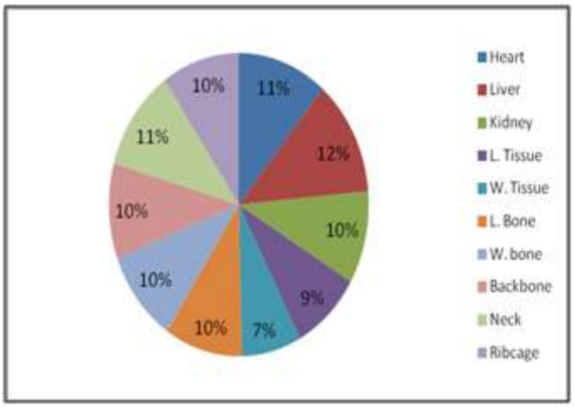

Fig. 3. Comparison of Mean Concentration of Cd in Different Parts of Poultry Meat.

The highest concentration of chromium (Cr) was detected in the kidney at 0.86±0.17 ppm while the lowest level of Cr was found in the heart at 0.30±0.20 ppm, both of which were lower than the allowed concentration of 1.0 ppm set by EU. In fact, all the chicken parts had lower levels of chromium than 1.0 ppm. Possible sources of chromium include the use of feed ingredient crops that had been fed with water contaminated with runoff water from tanneries; chromium is a major component of a tannery's effluent (3956 mg/l) (Waalkes *et al.*, 2003) and the use of solid waste from tanneries as a cheap and readily available source of protein in formulating the poultry feed. Lower levels of chromium documented in this study can be owing to the fact that environmental awareness has increased tremendously hence, many wastewater treatment plants have been set up in Kasur and heavy metal recovery from different processes is a quite common phenomenon than it was before.

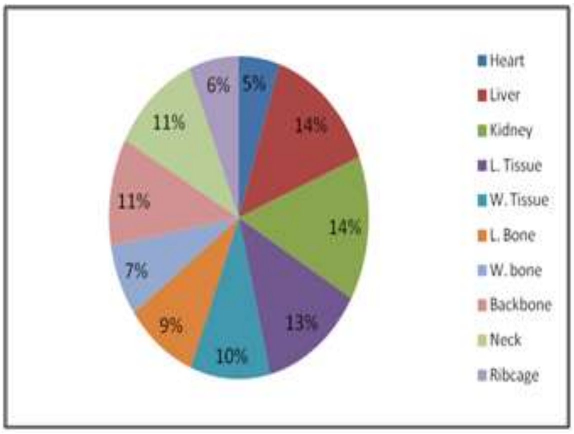

Fig. 4. Comparison of Mean Concentration of Cr in Different Parts of Poultry Meat.

The concentrations of Chromium found out by Mahmud *et al.* (2011) in Lahore in 2010 in the samples of heart, lean meat and neck bone except for kidney, leg bone, wing bone, and ribcage, were more than the one found out in this study. Khalil (2010) found chromium to be much higher in Kashmir while Akan *et al.* (2010) found it to be lower than the ones documented in this study. Half of the samples analysed by Iwegbue *et al.* (2008) had higher level of chromium while half had lesser levels than the ones in this study. Chromium is a human carcinogen and adversely affects the renal, hepatic, respiratory and immune system (Kaufman *et al.*, 1970). It causes functional and structural changes to the thyroid and pituitary glands (Mahmood *et al.*, 2008).

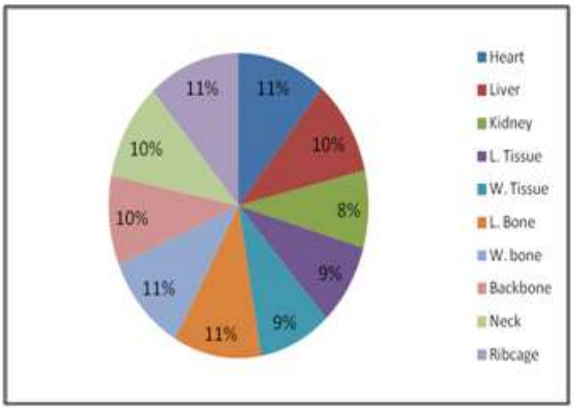

Fig. 5. Comparison of Mean Concentration of Cu in Different Parts of Poultry Meat.

Copper's (Cu) highest concentration (3.11±0.39 ppm) was in the ribcage and lowest was (2.23±0.45 ppm) in the kidney. Exposure to high concentration of copper causes histopathological alterations in the liver (Sharifian *et al.*, 2013) Wilson's disease, Menkes disease (Gu *et al.*, 2002), Alzheimer's disease (Brewer, 2010) and diabetes (Lamb *et al.*, 2001). But, the concentration of copper was not bothersome as it was way lower than the stipulated permitted level of 200 ppm by ANZFA. Higher concentration of copper was found out by Mariam *et al.* (2004) while Akan *et al.* (2010) found lower concentration of Copper than the one established in this research. Similar levels of Copper were found in Southern Nigeria by Iwegbue *et al.* (2008).

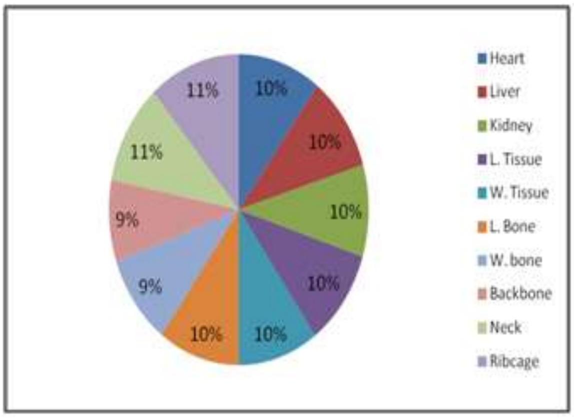

Fig. 6. Comparison of Mean Concentration of Fe in Different Parts of Poultry Meat.

Iron (Fe) is a very important trace metal required by our body but, in higher quantities it can cause hereditary hemochromatosis, arthritis, arthralgias, diabetes mellitus, liver fibrosis, cirrhosis, hepatic cancer and/or cardiac failure, parkinson's disease, Alzheimer's disease, Huntington's disease (Papamikolaou and Pantopoulos, 2005). The concentration of iron was the highest amongst all other metals; 86.73±9.43 ppm in the ribcage was the maximum concentration while 64.43±13.36 ppm in the backbone was the lowest recorded concentration. There is no permissible limit for iron given by any agency for neither poultry feed nor poultry meat. However; the nutrition requirement of iron by broiler chicks is 40 ppm as determined by the NRC (National Research Council) and all the levels of iron recorded in this research are almost twice the NRC requirement therefore, the quantity of iron supplements should be strictly monitored.

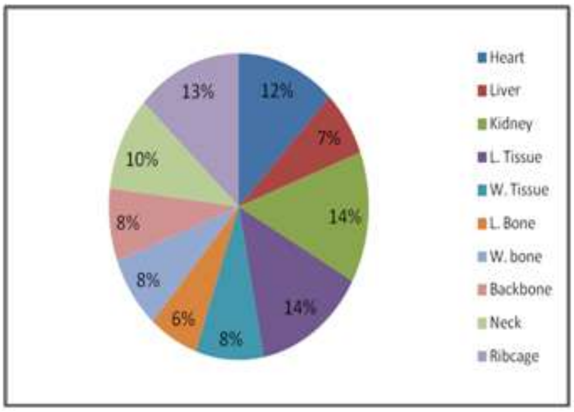

Fig. 7. Comparison of Mean Concentration of Hg in Different Parts of Poultry Meat.

The concentration of mercury (Hg) was higher in both the kidney and leg tissue at 0.18±0.11ppm while lowest concentration was observed leg bone at 0.08±0.11 ppm. Mercury also surpassed the tolerable level of 0.03 ppm given by ANZFA in all chicken parts but was lower than the permissible level of 1.0 ppm in fish meat, fixed by the EU. The high levels of mercury could be due to the broiler feed that has been prepared from contaminated fishmeal as it is a source of proteins. Moreover, mercury and coal bulbs are used by poultry farmers in place of proper electrical brooder for sustaining the temperature because of the electricity shortage and its subsequent price hike in Pakistan (Shah *et al.*, 2010). Mercury targets the nervous, renal (Charles and Margaret, 1993), lymphatic and immune systems (Rice, 1996). Mercury in all its forms is an etiological source of developing Alzheimers's Disease (Boyd, 2007). Methylmercury in higher concentrations can disturb brain development of the foetuses (Carpenter, 2001). Parkison's, Autism, Lupus, Armyotirophic lateral sclerosis diseases have also been linked to mercury (Zahir *et al.*, 2005). The results of the study carried out by Mariam *et al.* (2004) were more than the ones in this research.

Wing tissue showed maximum concentration of lead (Pb) (2.55±0.70 ppm) while rib cage had the minimum concentration of lead (1.47±0.69 ppm). Like mercury, the level of lead in all chicken parts exceeded the 0.1ppm concentration established by the EU and WHO and the limit of 1 ppm set by ANZFA as well. The high levels of lead can be sourced back to its presence in the tannery effluent (4.362 mg/l) (Waalkes *et al.*, 2003) which would have contaminated the water fed to the crops of poultry feed ingredient. Another source of lead is the vehicular emissions from combustion of leaded petroleum. Lead is a metabolic and neurotoxin which deactivates several vital enzymes (Cunningham and Saigo, 1993) and affects the gastrointestinal, nervous, renal, haemopoietic systems (Baykov *et al.*, 1996) and the reproductive systems (Rubio *et al.*, 2005). It can also induce lead poisoning in children as well as foetuses. Concentrations of lead were higher in this study as compared to the ones carried out by Sabir *et al.* (2003) in Peshawar, Akan *et al.* (2010) and by Mariam *et al.* (2004). Higher concentrations of lead were reported by Khalil *et al.* (2010). Lower lead levels except in two samples were documented by Iwegbue *et al.* (2008). Similar levels of lead were found by Oforka *et al.* (2012) in Nigeria.

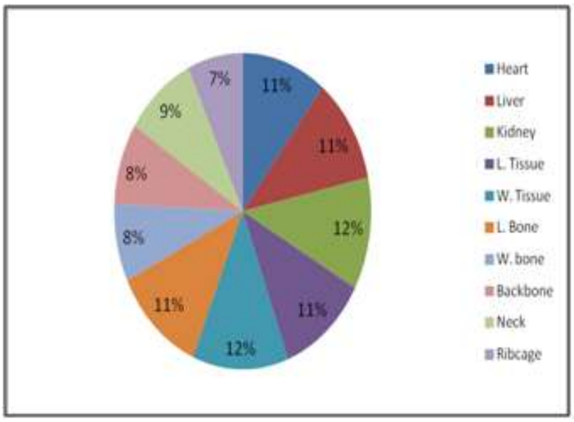

Fig. 8. Comparison of Mean Concentration of Pb in Different Parts of Poultry Meat.

The permissible level of nickel (Ni) at 0.5 ppm fixed by WHO was exceeded by ones found out in all the chicken parts. Liver showed the maximum concentration (3.88±0.73) of nickel while wing bone had the minimum concentration (2.70±0.40). Crops of feed ingredients contaminated with runoff water from tanneries, electroplating plants, battery manufacturing industry, oil and ghee industries are responsible for the high levels of nickel whose acute exposure can cause lung, nose, larynx and prostate cancer and the low level exposure can cause dizziness, lung embolism, birth defects, asthma and chronic bronchitis, skin rashes (IOCCC, 1996) contact dermatitis (Cavania, 2005). Some nickel compounds have been categorized as extremely potent carcinogens but this is limited to only people having occupational exposure (Diagma *et al.*, 2004). The concentration of nickel evaluated by Khalil, (2010); Iwegbue *et al.* (2008) were higher than the one found out in this study. On the other hand, Akan *et al.* (2010); Oforka *et al.* (2012) reported levels of nickel were lower.

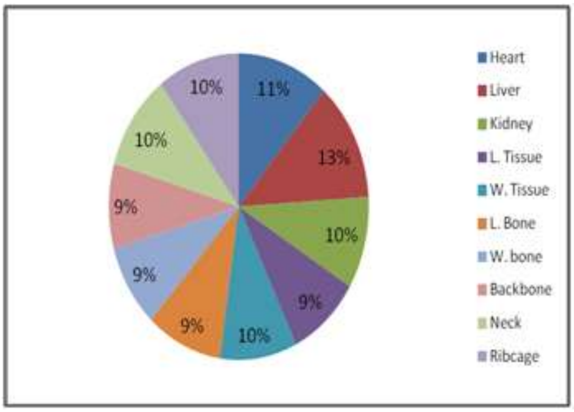

Fig. 9. Comparison of Mean Concentration of Ni in Different Parts of Poultry Meat.

Manganese (Mn) in high concentrations over prolonged exposure causes a mental disability called "Manganese psychosis" which induces uncontrolled laughter, euphoria, impulsiveness, sexual excitement and impotency (Khan *et al.*, 1990). Acute exposure to manganese affects lungs and causes metal fume fever, pneumonitis and pulmonary edema (ACGIH, 2001). Although, manganese is found in the crops of feed ingredients contaminated with runoff water from tanneries; (0.988 mg/l) (Gangwar, 2012), in petrol as an anti-knocking agent and is also added as a supplement in poultry feed; its reported levels in this study were lower than the permissible limit of 0.5 ppm except in wing bone and backbone, of which backbone had the highest concentration of Mn at 0.59±0.12 ppm while ribcage had the lowest concentration of Mn at 0.26±0.11 ppm. Concentrations of manganese were higher in this study than the ones carried out by Sabir *et al.* (2003); Iwegbue *et al.* (2008); Oforka *et al.* (2012); Akan *et al.* (2010) respectively.

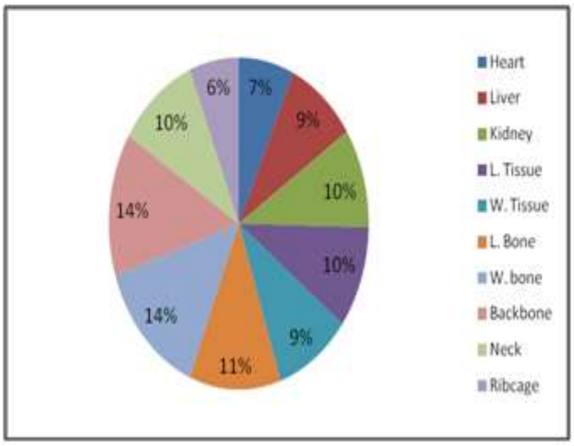

Fig. 10. Comparison of Mean Concentration of Mn in Different Parts of Poultry Meat.

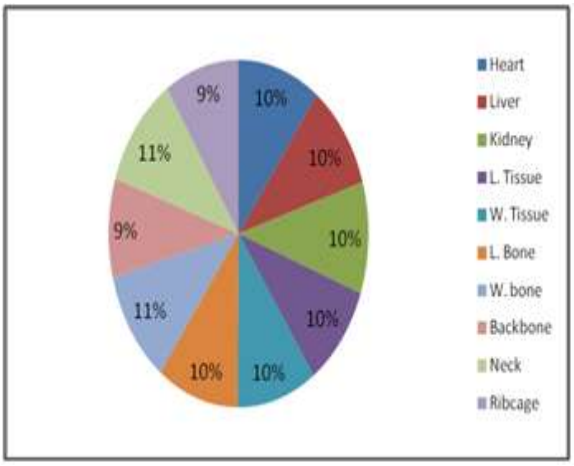

Fig. 11. Comparison of Mean Concentration of Zn in Different Parts of Poultry Meat.

Zinc (Zn) was highest in the wing bone at 34.26±6.61 ppm and lowest in the backbone at 29.57±5.92ppm. Nonetheless, both these values were considerably lower than the permissible limit of 150 ppm set by ANZFA. The high amount of zinc can be due to its addition as a supplement in poultry feed. Prolonged chronic exposure to zinc induces damage to pancreas, anaemia, lower levels of high density lipoprotein cholesterol (ANL; EVS, 2005). Concentrations of zinc were higher in this study as compared to the one carried out by Mariam *et al.* (2004); Sabir *et al.* (2003); Oforka *et al.* (2012); Khalil, (2010); Akan *et al.* (2010) while the one carried out by Iwegbue *et al.* (2008) had similar results.

Maximum percentage of arsenic (27%), chromium (14%), mercury (14%), were accumulated in kidney while liver had the highest percentage of cadmium (10 %) and nickel (13%), wing tissue had the most amount of lead (12%). Amongst the bones, ribcage had the highest accumulation of copper (11%) and iron (11%), leg bone had the maximum accumulation of manganese (11%) while neck bone had the highest maximum level of zinc (11%). Kidneys are responsible for cleaning the blood of toxins hence the highest level of heavy metals was found to have accumulated in them.

Conclusion

The research confirmed that the poultry meat being consumed in Kasur and its neighbouring cities is contaminated with heavy metals. The massive tanning industry present in Kasur is one of the major sources of heavy metals. Cadmium, lead, mercury, nickel exceeded the permissible limits set by EU, WHO and ANZFA while arsenic, copper and zinc were within limits. There is no permissible limit for iron which albeit, was present in twice the amount considered a requirement of chicks by NRC. Chromium was lesser than the allowable concentration given by EU. Manganese exceeded the permissible limit set by WHO in only wing bone and backbone. The maximum mean accumulation of heavy metals took place in kidney. Although the heavy metals are present in the meat but they are not too exceptionally high nonetheless, concerned authorities should take immediate action in order to curtail them below the threshold levels.

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