Estimation of chromium and copper in chicken liver samples by Inductively Coupled plasma–Optical Emission Spectrometry method


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ABSTRACT

Due to food safety issues and human health risk, heavy metal concentration through food chain is a concerned problem worldwide. There are several reports on transfer of non-biodegradable heavy metals from soil to animals by direct contamination or through feed. Hence, the present study was undertaken to estimate the presence of heavy metals chromium and copper in chicken liver samples (n=54) which were collected in and around Tirupati region of Andhra Pradesh, India. These samples were analyzed for the presence of chromium and copper by using Inductively Coupled Plasma–Optical Emission Spectrometer (ICP-OES). The excess levels of chromium considered to be carcinogenic and copper leads to tissue injury. The results of this study revealed that the range of chromium is between 0.009 to 0.091 ppm and for Copper is 0.006 to 2.54 ppm in chicken liver samples which is not significant and within prescribed tolerance limit.

Key words: Chicken livers, Chromium, Copper, ICP-OES.

INTRODUCTION

Food quality, safety and environmental contamination are primarily public health concerns worldwide (Falandysz et al., 2005). Contamination with heavy metals is a serious threat because of their toxicity, bioaccumulation and biomagnifications in the food chain (Demirizen and Uruc, 2006). Toxic elements can be very harmful even at low concentration when ingested over a long period. The essential metals can also produce toxic effects when the metal intake is excessively elevated (Celik, 2007). Food is mainly the important source of human exposure to heavy metals. Meat and meat products form an important source of human diet. Although the toxic content of the muscle is generally low, offal products like liver often accumulates higher metal concentrations than most other foods (Niedziolka, 2010).

The chicken meat is a major source of protein for the population and is widely preferred in India. However the data regarding the accumulation of heavy metal contents in chicken muscles and offal meats is very limited. Metals in chicken meats arise from the contamination of poultry feed, drinking water and processing (Iwegbue, 2008) due to natural occurrence in soil. These metallic residues hit by air to the source of fodder and water to drink used in poultry and due to the deposition of vehicle exhausts as most of the times the chicken retail shops are located on the road side especially in majority of the towns and cities in India. It is necessary to establish effective tests for accurate monitoring of heavy metal residues in chicken meat.

Chromium is the essential element helping the body to use sugar, protein and fat at the same time excessive amount is carcinogenic for organisms. Chromium occurs in several oxidation states in environment ranging from Cr^{2+} to Cr^{6+} (Rodriguez et al., 2009) commonly occurring forms are trivalent Cr^{3+} to Cr^{6+} with both states toxic to humans and plants (Mohanty and Kumar Patra, 2013). Anthropogenically chromium is released into the environment through sewage and fertilizers (Ghani, 2011). In India, the chromium level in underground water has been witnessed to be more than 12mg/L. The discharge of industrial wastes and ground water contamination has drastically increased the concentration of chromium ion in soil (Bielicka et al., 2005).

Cr III and Cr IV are the most stable form and only their relation to human exposure is of high interest (Zhitkovich, 2005). Cr IV compounds such as calcium chromate, Zinc chromate, Strontium chromate and lead chromate are highly toxic and carcinogenic in nature. In humans exposure to higher amounts can lead to inhibition of erythrocyte glutathione reductase, which in turn lowers the capacity to reduce methemoglobin and hemoglobin (Koutras et al., 1965). Once the chromium reaches blood stream it damages blood cells by oxidation reactions leading to hemolysis and subsequently liver and kidney failure. Different experiments have proved that chromate compounds can induce DNA damage in many different ways and lead to formation of DNA adducts chromosomal aberrations, sister chromatich exchanges, alterations in replication and transcription of DNA (O'Brien et al., 2001 and Matsumato

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Because of its mutagenic properties, Cr VI is categorized as a Group 1 human carcinogen by the International Agency for Research on Cancer (Dayan and Paine, 2001 and Zhang, 2011).

Copper is an essential trace element that is vital to the health of all living things (humans, plants, animals, and microorganisms). In humans, copper is essential to the proper functioning of organs and metabolic processes. Excess copper intake causes stomach upset, nausea, and diarrhea and can lead to tissue injury and disease. The oxidation potential of copper may be responsible for some of its toxicity in excess ingestion cases. At high concentrations copper is known to produce oxidative damage to biological systems, including peroxidation of lipids or other macromolecules (Bartzokis et al., 2000).

Keeping in view of the public health significance of chromium and copper, estimation of chromium and copper is carried out in chicken meat to determine their levels and to bring awareness among the public.

**MATERIALS AND METHODS**

The present study was carried out at the Department of Veterinary Public Health and Epidemiology, College of Veterinary Science, Tirupati during the month of December 2016 to estimate the level of heavy metal residues viz Chromium and Copper in chicken liver samples using Inductively Coupled Plasma Optical Emission Spectrometry method (ICP-OES). The chicken liver samples (n=54) collected aseptically and carried to the laboratory in sterile polythene bags. The samples were maintained at 4°C until processing. The samples were processed on the same day of collection. 2 g of sample was weighed and homogenized manually using mortar and pestle. Wet digestion procedure was followed for the digestion of liver samples. 2 g of sample was placed in a digestion tube and predigested in 10 ml of concentrated HNO₃ at 135°C until the liquor was clear. Thereafter 10 ml of HNO₃, 1 ml of HClO₄ and 2 ml of H₂O₂ was added and temperature was maintained at 135°C for one hour until the liquor becomes colourless. Product of digestion was allowed to slowly evaporate to near dryness. It was cooled and digested in 1 M HNO₃. The digests subsequently filtered through whatman filter paper No.1 and diluted to 25 ml in 1 M HNO₃ (Belton, 2006). The digested liver samples were presented for Inductively Coupled Plasma Optical emission Spectrometry method (ICP-OES).

Standard curves for the Cr and Cu analytes were prepared from stock solutions (standard concentrations of 1000 mg/ml) of metal analytes. To cover optimum emission working range 0.001 to 5.00 mg/ml serial dilutions was prepared. Usually freshly stored standard curves in the system software where available and was used. Blank solutions were also prepared accordingly. The external standard methods (Boss and Fredeen; 1997) of the Inductively Coupled Plasma Optical emission Spectrometry method (ICP-OES) were used for the determination of heavy metals (Cr and Cu). The (PERKIN ELMER ICP-OES 7000 DV) operational with SVS auto sampler was used for the determination of heavy metals. Samples were analyzed under the instrumental operating conditions. RF power 1.3 KW, outer argon flow 15.0 L/min, intermediate and inner argon flow 1.0 L/min and the nebulizer uptake rate (ml/min) 1.0 sample run were performed in replicate and integrated computer results of determinations will be recorded.

**RESULTS AND DISCUSSION**

The levels of heavy metals (Cr and Cu) obtained by Inductively Coupled Plasma Optic Spectroscopy method (ICP-OES) in chicken liver samples (n=54) collected from retail shops of different locations in Tirupati city, Cr and Cu levels were detected from all the 54 liver samples as per Fig 1 and with a minimum and maximum level of 0.009 and 0.091 ppm for Cr and minimum and maximum level of 0.06 ppm for Cu.

![Fig-1](image-url)  
**Fig-1:** Concentrations of copper and chromium levels in different chicken liver samples
and 2.54 ppm for Cu as per Fig.2. The offal products especially livers are often used in meat products and important source of metals Gonzalez-weller(2006), AOAC(1990). Copper and chromium are added to the poultry feed as these compounds are growth promoting, immunostimulating Chang et al.(1995) and other useful effects including reduction of fat and cholesterol in meat Seerly (1993). These heavy metals get bioaccumulates in principal organs like liver and kidneys Demirezen.O and Uruc.K (2006). Food is an important source of copper to humans as an essential element. Although copper is an essential element, it is toxic and maximum limit intake was set from 1 to 10 mg/day WHO(1996). Out of 54 samples analyzed all the samples found to have traces of copper which were measured at a wave length of 327.393nm. The concentration of chicken livers falls in the range of 0.006 to 2.54 ppm with a mean value of 0.99ppm which are lower than the values reported by Iwegbue(2008) which falls in a range of 0.01 to 5.15ppm. The concentration of copper in the liver samples in our study are similar to the findings of Bendeddouche (2004) in Algeria which falls in arrange of 0.005 to 2.30ppm and the findings of Thirulogachander et al.(2014) in Paladam District of Tamil Nadu with a mean value of 2.029ppm. the present findings are higher than the values reported by Okoye et al (2015) which are in a range of 0.115 to 0.445ppm and 0.1583ppm by Parekhan Aljaff (2014).

Chromium is an essential element in lower concentrations and at the same time chromium is carcinogenic in higher concentrations. The daily requirement for adults is estimated to be between 0.02 to 0.5 ppm per day. Several studies found that feed stuff accounts for the bulk of chromium intake by the poultry butressing most reports of food as being the major source of chromium. The levels of chromium in ppm is measured at a wave length of 267.716nm of wave length in the present study. The results revealed the presence of chromium in all the liver samples in a range of 0.009 to 0.091 ppm with a mean value of 0.055ppm. The present findings are much lower than the values reported by Abdullahi Idi Mohammed (2013) which is 0.104 in Maidiguri, Nigeria. Thirulogachander et al. (2014) reported much higher levels of chromium in chicken livers in Paladam District of Tamil Nadu that is 1.224ppm whereas, Parekhan Aljaff (2014) reported 0.086ppm in Sulaimani, Iran. The present findings of our study revealed the presence of Copper and Chromium in chicken livers a perishable food of choice are within the permissible limits that is 0.77 ppm for Chromium and 106ppm per copper. The heavy metal levels can be reduce by more careful handling processes and processing of raw materials. Primary sources of heavy metals include trash, raw sewage and harmful gas emissions from various places Mutluer (1989) and Yavuz and Filazi(1995). Proper covering of meat at meat shops can reduce contamination from open air up to 90 percent. Further more thorough washing of meat removes to some extent Sabir et al.(2003).

CONCLUSION
Our study can be guided to identify the sources of contamination of chromium and copper in chicken samples in order to take safety measurements to ensure that these chicken livers are safe for consumption to safeguard the public health.

REFERENCES


