▼ Journal of Research (Science), Vol. 26-27, No. 1-4, Apr 2021, pp. 1-7
ISSN 1021-1012

Investigation of Trace Metals in Poultry Egg Purchased from Karachi, Pakistan

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Abstract

Heavy metals contamination in food commodities is a serious threat because of their toxicity, bio-magnification and bioaccumulation in food chain, which has been increasing day by day. Poultry egg is the major source of nutrients and protein. The current study was carried out to investigate alarming levels of heavy metals Cd, Co, Cu, Fe, Pb, and Mn in poultry egg sold in entire five districts of Karachi, Pakistan. The egg yolk and albumin were digested in nitric acid separately and heavy metal concentration was determined by atomic absorption spectrophotometer (AAS). The concentration of Cd, Co, Cu, Fe, Pb, and Mn in albumen of egg was found in a range of 0.10-0.16ppm, 1.36-2.60ppm, 2.92-5.55, 48.5-58.9ppm, 4.00-8.55 and 2.28-5.82ppm respectively. The concentration of Cd, Co, Cu, Fe, Pb, and Mn in yolk of egg was found in a range of 0.06-0.09ppm, 0.65-1.56ppm, 7.12-10.20ppm, 98.8-118.8ppm, 2.30-4.85ppm and 14.8-34.8ppm respectively. Heavy metals concentrations were found in descending order Fe> Mn> Cu> Pb> Co> Cd in egg albumin as well as egg yolk of sample analyzed for entire five districts of Karachi. The high levels of heavy metals in poultry eggs detected in the period of studies could be a serious risk to human health in the largest populated city of Pakistan, where limited resources are available for the prevention and controlling their levels in the food supply.

Keywords: Heavy metals, chicken egg, egg albumen and egg yolk,

Introduction

Heavy metals pollution is a serious threat to human lives that is continuously damaging the eco system. Due to their simple mechanism of bio-magnification and bioaccumulation in food chain, heavy metals indulge more toxic effects (Demirezen and Uruç, 2006). Most elements enter the body through diet. These contaminants often have direct physiological toxic effects as they are stored or accumulated in tissues, sometimes permanently (Bokori *et al.*, 1996, Mariam *et al.*, 2004). Hen eggs provide sufficient amount of protein, fat, carotenoids, vitamin and minerals (Applegate, 2000, Herron and Fernandez, 2004, Kiliç *et al.*, 2002). The egg albumin attracts metals ions such as Hg, Zn, Cu and Fe, and egg yolk can attract I, Cr, Ni and Zn (Dobrzański *et al.*, 2007).

Fish meal byproducts (head, fins, scales, skin, bones, and viscera) are considered as a good feed for chicken production in developing countries, because it is proved to be a good protein source, fat, vitamin and minerals and can be used to supplement vegetable protein sources such as soybean meal, canola meal and rapeseed meal (Karimi, 2006, Blair, 2008, Raza *et al.*, 2003). In a study carried out in Karachi, Pakistan As, Co, Cu, Mn and Pb were detected in marine fish species raising questions on the use of marine fish byproducts as chicken feed(Noël *et al.*, 2012). Excessive use of such contaminated chicken feed can be one reason of accumulation of such trace metals in poultry meat and eggs as well as in human after its consumption. It is already reported that use of excessive amount of all essential and non-essential trace element make them toxic for

Received 26 Dec 2020; Revised 16 Feb 2021; Accepted 26 Mar 2021

human consumption (Young *et al*., 1994). The estimation of trace metal in egg in China and Australia also supports this statement (Williams and David, 1973, Anderson, 1972).

Keeping in view the hazard posed to general public health through utilization of contaminated poultry eggs, it has become essential that immediate attention should be taken by the researcher as well as regulatory authorities. It is a dilemma for the Asian countries that most of the information regarding heavy metal contamination and diseases caused by such contamination in livestock, meat, poultry and fish are only available through literature of western countries, due to which it has become essential to evaluate significant threat to human from heavy metal contamination in largely grown and consumed livestock. Therefore, the current study was carried out to investigate alarming levels of heavy metal such as Cd, Co, Cu, Fe, Pb, and Mn in poultry egg sold in Karachi. The study will be the benchmark in estimating the potential risk from the effects of trace metals accumulation in human through poultry egg. The study helps to the health protecting agencies to carryout regulatory action to stop such contaminations.

Materials and methods

Collection of samples

A total of fifty chicken eggs were purchased from local outlets of five districts (10 from each district) of Karachi. Administrative divisions of the city include five districts, namely Karachi East, Karachi West, Karachi Central, Karachi South, and District Malir. The samples were carefully kept in refrigerator and were analyzed as soon as possible.

Chemicals and reagents

Tecator digester model-2006 was used for wet digestion. Perken-Elmer model-2380 atomic absorption spectrophotometer (AAS) equipped with air acetylene flame was used for trace metal analysis. Pyrex glassware pre-washed with nitric acid and then with deionized water was used.

Digestion

Each egg was first broken into egg yolk (Y) and albumen (A) and then examined separately. One gram of each sample (egg white and egg yolk) was taken into digestion tube (Tecator-2006).10 mL of concentrated nitric acid (65%) was added and sample was allowed to stand for 24 hours. The tube was then heated for 30 minutes till all NO_2 are removed. The tube was then cooled and 15mL concentrated nitric acid was added to it. The tube was then heated for 30 minutes at 120^{o}C and then 150^{o}C till the digestion was completed. The sample was cooled at room temperature then 2 mL perchloric acid (70%) was added. Digested sample was then diluted to 50 mL by deionized distilled water (Kabeer *et al.*, 2020).

Elemental analysis of the samples

Absorption of stock and samples were measured by AAS. Using standard operational conditions trace metals content was estimated in the digested solutions. Blank run on the acid used were conducted to incorporate background correction. Determinations of Cd, Co and Pb were carried out by Flameless and Cu, Fe and Mn by Flame Atomic Absorption Spectrometry. Analysis of each

metal was carried out in triplicate to get representative result and reported in ppm. Precision of the method was determined by Coefficient of Variance (CV).

Results and discussions

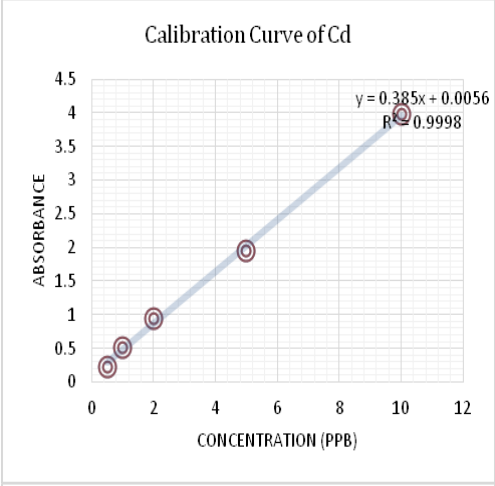
Detection limits and calibration curves

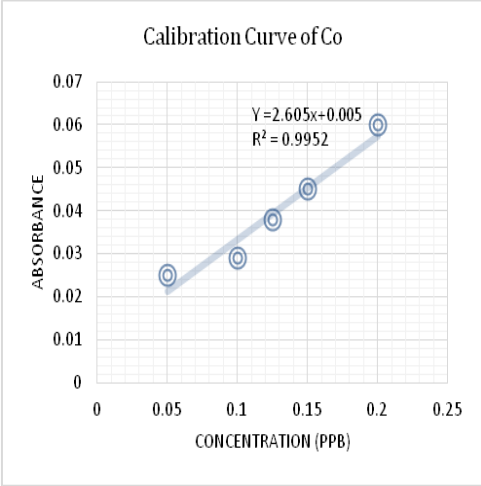
The detection limits of Cd, Co, Cu, Fe, Pb, and Mn were estimated and are summarized in Table-1

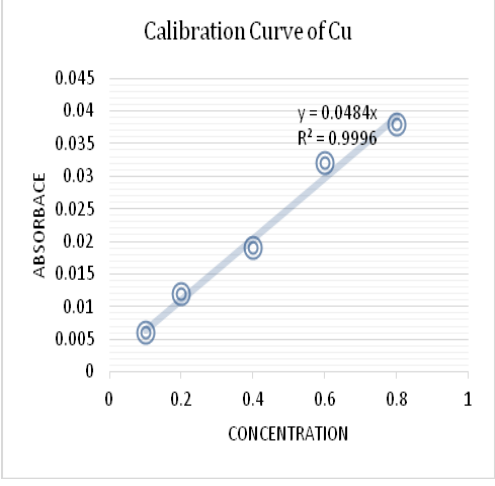
Table-1: Experimental Conditions for Cd, Co, Cu, Fe, Pb, and Mn Determinations by AAS

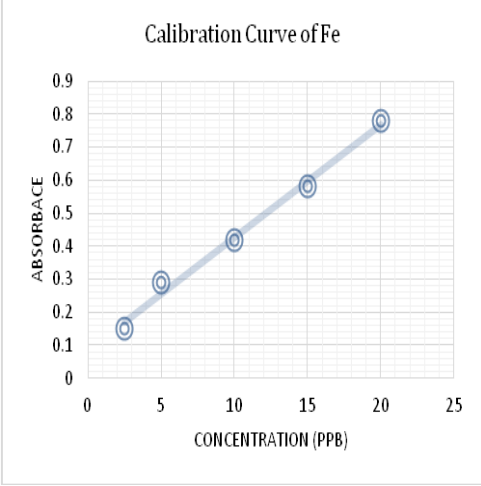
Metals	Wave Length (nm)	Lamp Current (mA)	Detection Limit ($x10^3$ ppb)
Cd	228.8	15-25	0.2
Co	240.7	15-25	2.4
Cu	324.8	15-25	15
Fe	248.3	20-30	25
Pb	283.8	10-25	2.5
Mn	279.5	20-30	8.0

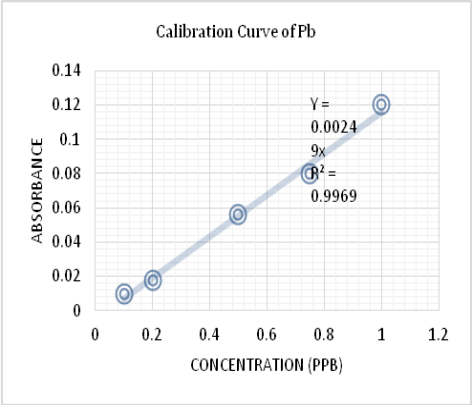
The Calibration curves of Cd, Co, Cu, Fe, Pb, and Mn are shown as Fig-1.











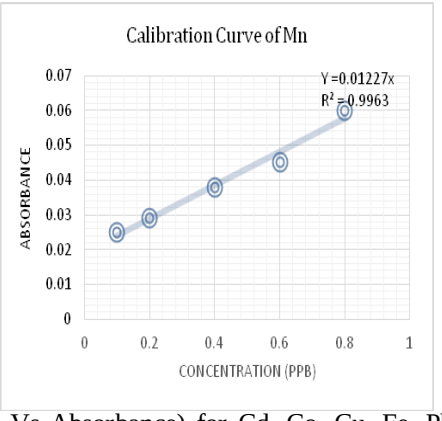


Figure 1: Calibration Curves (Concentration Vs Absorbance) for Cd, Co, Cu, Fe, Pb, and Mn

Table 2: Heavy metal Concentration in ppm (means ± SE) in Albumin of Chicken Egg

Sampling Site	Cd	Co	Cu	Fe	Pb	Mn
Karachi East	0.12±0.001	1.36±0.003	2.92±0.04	48.5±0.7	4.00±0.03	2.28±0.03
Karachi West	0.14±0.002	2.56±0.004	5.55±0.04	54.2±0.9	7.26±0.03	5.18±0.03
Karachi Central	0.10±0.001	1.61±0.001	3.28±0.04	58.9±0.9	5.35±0.04	3.65±0.04
Karachi South	0.16±0.002	2.60±0.003	5.18±0.03	49.1±0.7	8.55±0.04	5.82±0.04
District Malir	0.12±0.002	2.50±0.002	5.20±0.05	50.8±0.8	6.18±0.03	5.38±0.03

Table 3: Heavy metal Concentration in ppm (means ± SE) in Yolk of Chicken Egg

	Cd	Co	Cu	Fe	Pb	Mn
Karachi East	0.08±0.001	0.65±0.003	7.12±0.04	106.5±0.7	2.30±0.03	14.8±0.03
Karachi West	0.07±0.002	1.56±0.004	9.85±0.04	108.8±0.9	4.12±0.03	34.8±0.03
Karachi Central	0.06±0.001	0.86±0.001	9.28±0.04	118.8±0.9	2.43±0.04	22.5±0.04
Karachi South	0.09±0.002	1.56±0.003	9.90±0.03	98.8±0.7	4.85±0.04	33.2±0.04
District Malir	0.07±0.002	1.40±0.002	10.20±0.05	.115.5±0.8	3.48±0.03	34.8±0.03

The analytical results of heavy metals concentration in chicken egg albumin and yolk are summarized in Table-2 and Table-3 respectively. Occurrence of heavy metals was detected for all samples. Cadmium was found minimum and Fe was found as maximum in all egg albumin and egg yolk samples analyzed. The concentration of Cd, Co, Cu, Fe, Pb, and Mn in albumen of egg was found in a range of 0.10-0.16ppm, 1.36-2.60ppm, 2.92-5.55, 48.5-58.9ppm, 4.00-8.55 and 2.28-5.82ppm respectively. The concentration of Cd, Co, Cu, Fe, Pb, and Mn in

yolk of egg was found in a range of 0.06-0.09ppm, 0.65-1.56ppm, 7.12-10.20ppm, 98.8-118.8ppm, 2.30-4.85ppm and 14.8-34.8ppm respectively.

The data of heavy metals concentration in chicken egg albumin, summarized in Table-2 indicates that the amount of Fe was found as maximum with a range of 48.5-58.9ppm, and Cd was found minimum with a range of 0.10-0.16ppm. The concentration of all heavy metals is found maximum in the egg purchased from Karachi South, except Fe which is found maximum in the samples of Karachi Central. However minimum concentration of heavy metals is detected in the egg samples purchased from Karachi East except Cd which is found minimum in the samples of Karachi Central. Heavy metals concentrations were found in descending order Fe> Mn> Cu> Pb> Co> Cd in egg albumin sample analyzed for all five districts of Karachi.

The data of heavy metals concentration in chicken egg yolk, summarized in Table-3 indicates that the amount of Fe was found as maximum with a range of 98.8-118.8ppm, and Cd was found minimum with a range of 0.06-0.09ppm. The concentration of Cd, Cu and Pb is found maximum in the egg purchased from Karachi South, whereas concentration of Cu and Mn is detected maximum in Malir District and Fe in the samples of Karachi Central. Minimum concentration of Co, Cu, Pb and Mn is detected in the egg samples purchased from Karachi East, Cd is found minimum in the samples of Karachi Central and Fe is detected minimum in the samples of Karachi South. Heavy metals concentrations were found in descending order Fe> Mn> Cu> Pb> Co> Cd in egg yolk sample analyzed for all five districts of Karachi.

Discussion

It can be reveal from the result of current study that egg albumin contained higher concentration of Cd, Co and Cu (Table-2) whereas significantly higher concentrations of Fe, Mn and Pb were observed in egg yolk samples (Table-3). It might be due to the fact that migration of Pb and Cd across the membrane form albumen to yolk has been inhibited due to larger ionic radii of Cd and Co [7]. The results of current study are comparable to a study in which heavy metals (Ni, Pb, Zn, Mn, Cr, Cu and Se) were quantified for 90 samples of egg and 12 samples of poultry feed. Results showed that the concentration of Pb, Cr and Se in egg white, egg yolk and poultry feed were found above permissible limits (Rahman *et al.*, 2014). The results of current study are found lesser then a study in which heavy metals includes Fe, Mn, Pb, Cd, Cu, Zn etc. were analyzed using AAS (Khan *et al.*, 2016). The findings of the present study were higher than the results reported earlier (Khatoon *et al.*, 2006).

It has been established through literature that most of the poultry farms use fish by-products (head, fins, scales, skin, bones, and viscera) as poultry feed in Karachi (Tabinda and Butt, 2012, Tariq *et al.*, 1993). On the other hand, heavy metals are detected in marine fish samples of Arabian Sea in excessive amount (Raza *et al.*, 2003, Ali *et al.*, 2013, Kakar *et al.*, 2020, Vodela *et al.*, 1997b, Vodela *et al.*, 1997a). The high amount of heavy metals in poultry feed can be accumulated in the chicken and transferred to the egg which has become a serious threat for the consumer. Drinking water can also be a source of contamination, particularly in areas where groundwater is near hazardous waste

sites. In Karachi two industrial area streams contain untreated effluents and are carrying toxic heavy metals to the sea which is making them a major source of toxifying Arabian Sea (MAQSOOD and RAZA, 2011). These untreated effluents contaminate marine organism which on consumption as poultry feed toxifying the chicken eggs.

Conclusion

The present study revealed elevated concentrations of heavy metals in commonly consumed eggs. Heavy metals concentrations were found in descending order Fe> Mn> Cu> Pb> Co> Cd in egg albumin as well as egg yolk of sample analyzed for all five districts of Karachi. In the albumin samples, the concentration of all heavy metals is found maximum in the egg purchased from Karachi South, except Fe which is found maximum in the samples of Karachi Central. Whereas in the egg yolk samples, the concentration of Cd, Cu and Pb is found maximum in the egg purchased from Karachi South, Cu and Mn were detected maximum in Malir District and Fe in the samples of Karachi Central. The high concentration of heavy metals detected in the egg samples of five districts of Karachi city is a serious threat to human.

The results of current study raised the requirement of regular monitoring of the foodstuff especially poultry eggs supplied to the city of Karachi, Pakistan and the samples exceeding the allowable limit can be restricted to bring in the market. Detoxification of industrial effluents may also be controlled, which carry toxic heavy metals to the sea, toxifying the Arabian Sea. Further studies are needed to find out the exact sources of heavy metals in poultry eggs.

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