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Determination of some heavy metals in hen eggs using ICP-AES technique

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Abstract: This study was focused on evaluating the essential trace metals level in hen egg that collected from local market of London, UK. The concentration of Pb, Cd, Cr, Co, Cu, Fe, Mn, and Zn were analyzed by using inductively coupled plasma atomic emission spectrometry (ICP. AES). Cadmium and cobalt were not found in any egg sample. The mean concentration of analysed hen egg sampl was within permissible limit (PL) for Pb, Cu and Zn.

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INTRODUCTION

Fresh eggs are among the most important and nutritious food in the daily diet. Moreover, egg included in several food products for various functions[1,2]. Global Environmental pollution through heavy metals lead to an increased interest in metals contamination of food stuffs and amongst them eggs which symbolize an important part of human's diet especially children due to the hen eggs is an important source of nutrients, containing all of the protein, lipids, Vitamins and minerals[3]. Metalic elements are found in all living organisms where they perform a variety of roles, as structural, components of control mechanisms (e.g. in nerves and mescals) and enzyme activator. Trace metals like Cr, Co, Cu, Fe, Mn and Zn are essential metals and also called micronutrients[4] and are toxic when taken in excess of requirements[5]. Where as, especially lead (Pb), Cadmium (Cd) mercury (Hg) and arsenic (As) are non-essential metals and even toxic in trace amount[6]. The toxic limit and recommended or safe intake of heavy metals for human health is given in by[7]. Essential elements deficiency results in impairment biologically function, but when their intakes exceed the recommended quantities significantly have harmful effect and even may be toxic[8]. Copper is an essential trace element, normal constituent of animal tissues and fluids, crucial in hemoglobin synthesis and other enzymes functions. Both deficiency and excess of Cu in the mammalian system result in untoward effects[9]. Toxic level of Cu may lead to Wilson's disease (excessive accumulation of Cu in liver, brain, kidney and cornea) and Menkes's disease[10]. Zinc is one of most abundant nutritionally essential element in the human body. It is essential to the structure and function of large number of macromolecules and for over 300 enzymatic reactions[11]. Zinc plays a role in immune function, protein synthesis, wound healing, DNA synthesis and cell division; consequently it supports normal growth and development during pregnancy, childhood and adolescence[12] lead found everywhere in the environment and at low levels in almost all living organisms[13].

The general population is exposed to lead from air and food. During the last century, Pb emission from petrol to ambient air caused considers able pollution[14]. Lead ingested by chicken through contaminated feed is deposited in bones. soft tissue and eggs, so the contaminated egg represents a potential public health hazard. As lead can be sequestered from hen to egg, repeated consumption of contaminated eggs from a family owned flocks provide continuing dietary source of lead[15] Cadmium is a toxic to virtually every system in the animal body. It is almost absent in the human body at birth but accumulates with age. However food is the primary source of cadmium exposure[16], and its adverse health effects occur in the form of kidney damage but possibly also bone effects and fracture[14]. Iron is an essential trace element whose biological importance arises form its involvement in vital metabolic function by being cytochromes[17], Iron deficiency is the most prevalent single nutritional deficiency in the world and is the main cause of anemia in infants, children, adolescents and woman of child bearing age[18].

Manganese is usually occurring with iron and it one of the most abundant metal in the earths crust. It is found naturally in its pure state but it is a component more than 100 minerals[19]. Manganese perform significant part in different metabolic process in human, animals, microorganism and plants the deficiency of manganese is very rare that is its presence every where and is found in many food[20].

Chromium is an essential element for human beings, further it acts in the organism as maintaining normal glucose tolerance[21]. Trivalent chromium

found in most food and nutrient supplements, is an essential nutrient with very low toxicity. Hexavalant chromium compound have been shown to be potent occupational carcinogens[22].

MATERIALS AND METHODS

Sample collection

A total of 40 samples of various types of eggs were collected, 6-10 samples of egg in a batch, were obtained from departmental stores of South Hall Local market of London UK.

Preparation of egg samples

Each egg was washed with de-ionized water the yolk and egg white were mixed in a 200ml beaker. A portion (5-10gm) of mixed sample was accurately weighed into 100ml beaker and 5-10ml 65% concentrated H NO_3 was added and covered with watch glass. After 30 min the beaker was placed on hot plate upto 140°C until the complete decomposition of sample was achieved and the total volume was reduced to nearly 3-5ml. the digested sample was cooled and filtered into a 50ml calibrated flask.

RESULTS AND DISCUSSION

The analytical results shown in table 1 reveal that mean value of lead content in big fresh egg, organic medium egg & free range organic egg samples are 0.0242, 0.0530 and 0.1932 $\mu g/g^{-1}$ fresh wet weight. According t lead PL (0.05ppm) cited by[23], the examined egg samples big fresh egg organic medium egg and free range organic egg samples are with in permissible limit and the remaining samples the results are below detection limit. The average lead concentration in egg sample free range organic egg found larger than the average value of 69 µg/kg fresh weight reported by[24]. Lower concentration (mg/kg) of lead in egg was reported by other researchers, 0.0116 in autumn and 0.0738 in spring[25].

On their other hand cadmium can not be detected from any hen egg samples (Table 1). The concentration of Cd was also found below the limit of quantification for the majority of samples[25]. Van overmeire et al., 2006 reported average cadmium level of 0.53 and 0.27 mg/kg in private commercial farms egg. Fakayoda and Olu-Owolabi (2003) reported that the content of cadmium in eggs was 0.07 mg/kg which was comparatively greater than the levels found in other countries. The PL of cadmium according to[23] is 0.05ppm and all of the egg samples are below the permissible limit.

The copper content of the eggs studied are presented in table 2, the copper concentration in free roam eggs sample in the range 4.7332-6.5781μgg^{-1} the copper content in various egg components was found in the range 0.237-2.24mg/kg[26]. The average content of copper 0.60 and 0.51mg/kg in eggs obtained from private owners and commercial free range chicken egg in Belgium[24]. The table 2 reveal that the results are differ greatly from the levels determined in eggs from other countries by other investigators as 0.43 mg/kg in autumn and 0.52 mg/kg in spring in the home produced egg in Belgium[25] while 0.59 mg/kg in fresh egg[28] 0.78 in Nigeria[26] and 0.62 mg/kg in British eggs[29]. The concentration of copper (Table 2) significantly higher in free to roam egg samples but these valves are within permissible limit (10ppm)[23]. Copper is essential trace element for several enzymes in the body of the bird[10] as well as most copper is stored in liver, bone and bone marrow where it is bound to metallothionine[30].

The iron content in various types of egg samples was found higher in the organic medium egg in the range 4.4071-18.40µg/gm (Table 2) Zbigniew Dobrzanski et al., (2007) reported that the iron content in egg sample was in the range 0.301-72.02mg/kg. The mean concentration of iron 22.07mg/kg was determined in Santiago Chile[18]. Iron content in egg sample in the range 21.80 -24.10 in Nigeria[26] and 20mg/kg in British egg[29].

Table 1: Levels of lead (Pb), cadmium (Cd), chromium (Cr) and cobalt in hen eggs

Eggs Samples	Lead (µg/gm)			Cadmium (µg/gm)			Chromium(µg/gm)			Cobalt (µg/gm)		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
Big & Fresh	0.1453	0.1453	0.242	ND	ND	ND	0.1699	0.1453	0.0787	ND	ND	ND
Fresh Bran	ND	ND	ND	ND	ND	ND	0.4436	0.1714	0.1403	ND	ND	ND
Organic Med.	0.1622	0.1556	0.0530	ND	ND	ND	0.1694	0.1556	0.0812	ND	ND	ND
Free to Roam	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TESCO Value	ND	ND	ND	ND	ND	ND	0.2131	0.0886	0.1095	ND	ND	ND
Free Range Organic	1.9315	1.9315	0.1932	ND	ND	ND	0.2414	0.0.1159	0.0660	ND	ND	ND

Table 2: Levels of copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn) in hen eggs.

Eggs Samples	Copper (µg/gm)			Iron (µg/gm)			Manganese (µg/gm)			Zinc (µg/gm)		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
Big & Fresh	1.0598	0.7267	0.8406	15.0493	8.9859	12.2790	0.5099	0.2906	0.3647	13.7675	9.5145	11.6151
Fresh Bran	4.2091	1.0286	2.3826	17.4409	12.6274	15.2069	0.453	0.3428	0.2066	15.6288	11.3019	13.3841
Organic Med.	1.0167	0.7784	0.9148	18.4092	4.4071	10.5496	0.5083	0.2262	0.4067	15.5897	12.7664	14.0769
Free to Roam	6.5781	4.7332	4.5545	17.8821	14.3623	13.7783	ND	ND	ND	33.2097	14.3623	17.7437
TESCO Value	0.8868	0.437	0.6227	16.8396	5.6904	10.2496	0.4263	0.2185	0.3439	14.2817	10.5525	12.4874
Free Range Organic	1.1702	0.3779	0.7233	15.5489	2.1554	7.4325	0.4063	0.1950	0.2773	12.9327	8.1181	10.8849

The manganese content in various types of egg samples was found higher in the big fresh egg samples in the range 0.2906-0.5099mg/kg (Table 2). Ysart et al., 2000, recorded that the mean value of manganese 0.31mg/kg in egg samples which lower than the values found in table 2.

Results recorded in table 2 reveal that the mean concentration of Zinc were found lower than the concentration of Zn in eggs were reported by other researches, 53.35, 60.56 and 49.76mg/kg in commercial, home produced and organic eggs[31] 20.3 mg/kg in autumn and 19.2 mg/kg in spring[25].

Van overmeire et al., 2006, reported that the value of zinc 11.5mg/kg in private owners' eggs and 9.7mg/kg in commercial farm chicken egg were low then the values found in table 2. All the recorded values of zinc content in egg samples in table 2. lower than the permissible limit PL (20ppm) according to polish limit cited[23].

CONCLUSION

The concentration of essential trace metals were not found higher within the permissible limit cadmium was not found in any egg sample whereas lead in not found in fresh bran egg free to roam egg and Tesco value egg. The decrease in dietary exposure affects the success of measures taken by the UK and European Commission to reduce lead exposure and contamination of food (e.g. lead free petrol, greater use of welded cans, the banning of lead seals on wine bottles etc).

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