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RISK ASSESSMENT OF SOME HEAVY METALS IN EDIBLE CHICKEN GIBLETS

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ABSTRACT

A total of 60 random samples of edible chicken giblets were collected from different markets in Kafr El-Sheikh governorate, Egypt, to evaluate their levels of some heavy metals as Lead, Copper, Zinc and Chromium. The obtained results indicated that the mean values of Lead, Copper, Zinc and Chromium concentrations in liver chicken samples were 0.47 ± 0.08, 5.13 ± 0.59, 5.27 ± 0.59 and 0.38 ±0.08 mg/kg, respectively. While these concentrations in gizzard chicken samples were 0.24 ±0.06, 3.57 ±0.45, 3.15±0.39 and 0.22±0.06, respectively. Also these concentrations in heart chicken samples were 0.09 ± 0.024, 1.77 ± 0.26, 2.23 ± 0.26 and 0 (not detected). So these obtained data were compared with the permissible limits of (FAO/WHO, 1884) and (Egyptian Standard, 1993) and the public health risk of such toxic heavy pollutants metals was discussed.

INTRODUCTION

Heavy metals have recently come to be dangerous substances and are considered as serious chemical health hazards for men and animals. **(Lars, 2003).** Several heavy metals are known to be essential at low concentrations, but at high levels they are toxic. The problem is complicated where there is a very narrow range between the concentration at which the metal is considered essential and the concentration at which it is considered toxic. **(Higham and Tomkins, 1993).**

However, heavy metals cannot be destroyed or broken down over long time of heat treatment. So, chicken giblets subjected to cooking and/or serving may constitute public health hazard. From these metals is copper which is a component of many body proteins, almost all of the body's copper is bound to copper proteins. Unbound (free) copper ions are toxic. Genetic mechanisms control the incorporation of copper into apoproteins and the processes that prevent toxic accumulation of copper in the body. Copper absorbed in excess of metabolic requirements is excreted through bile. **(Joseph, 2001and Merck, 2005).**

Copper is aids in the formation of red blood cells, and works with Vitamin C to form elastin whish is an important protein that makes up bone, skin and connective tissue. It aids in the healing process and energy production. This mineral is needed for healthy nerves and joints. **(Washington, 1980**).

The second metal is Lead which is recognized as toxic substance which accumulates in the body due to its low rate of elimination, lead affects virtually every one of the body's organ systems, primarily the nervous system. **(Sanders et al 2009),** but also the cardiovascular system, the hemopoietic system, the liver, the kidneys, and reproductive systems in both males and females. **(Flora et al., 2008**)**.** Evidence suggests lead exposure is associated with high blood pressure, and studies have also found connections between lead exposure and coronary heart disease, heart rate variability, and death from stroke, but this evidence is more limited.(**Navas et al., 2007),** People who have been exposed to higher concentrations of lead may be at a higher risk for cardiac autonomic dysfunction on days where the ozone and fine particles are higher**.(Park et al., 2008).**

The third metal is zinc whish is an essential mineral that is naturally present in some foods, added to others, and available as a dietary supplement. Zinc is also found in many cold lozenges and some over-the-counter drugs sold as cold remedies. Zinc is involved in numerous aspects of cellular metabolism. It is required for the catalytic activity of approximately 100 enzymes **(Sandstead, 1994 and Institute of Medicine, Food and Nutrition Board, 2001**). And it plays a role in immune function, (**Prasad, 1995 and Solomons, 1998)**. Protein synthesis **(Prasad, 1995),** wound healing **(Heyneman ,1996**), DNA and RNA synthesis and cell division (**Prasad 1995 and Institute of Medicine, Food and Nutrition Board, 2001).**Zinc also supports normal growth and development during pregnancy, childhood, and adolescence **(Simmer** & **Thompson, 1985 and Maret** & **Sandstead, 2006)**. And is required for proper sense of taste and smell (**Prasad et al., 1997).** A daily intake of zinc is required to maintain a steady state because the body has no specialized zinc storage system **(Rink and Gabriel, 2000).** Zinc deficiency is characterized by growth retardation, loss of appetite, and impaired immune function. In more severe cases, zinc deficiency causes hair loss, diarrhea, delayed sexual maturation, impotence, hypogonadism in males, and eye and skin lesions, **(Hambidge, 1989; Prasad et al., 1997; Institute of Medicine, Food and Nutrition Board, 2001 and Maret** & **Sandstead, 2006)**.Weight loss, delayed healing of wounds, taste abnormalities, and mental lethargy can also occur. **(Heyneman, 1996; Nishi, 1996 and Maret** &**Sandstead, 2006).** Many of these symptoms are non-specific and often associated with other health conditions. Therefore a medical examination is necessary to ascertain whether a zinc deficiency is present or not.

The fourth metal is chromium which has become a subject of much interest in recent years, and we continue to learn more about it. Chromium was long thought to be a toxic mineral until it was discovered in 1957 to be the essential part of glucose tolerance factor (GTF).So it is an essential mineral—that is, it is not made by the body and must be obtained from the diet. As the central part of GTF, it enhances the effect of insulin in the body. GTF is necessary for proper insulin function in the utilization of glucose and is needed in both human and animal nutrition for carbohydrate metabolism. Specifically, chromium/ GTF improves the uptake of glucose into the cells so it can be metabolized to produce energy (ATP), (**Kotaś and Stasicka,2000**).Chromium in food is low and present in 2 forms, trivalent form is the biologically active form and Hexavalent form (+6) which is fairly unstable and is potentially toxic in the body .The major effect of chromium poisoning related to hexavalent from which characterized by acute renal tubular necrosis associated with cancer of respiratory tract **(Bryson, 1989).** Chromium recently has been shown to lower blood cholesterol while mildly raising HDL (high-density lipoprotein).This lowers the risk ratio for coronary artery disease. (Exercise is a key factor in raising HDL cholesterol and reducing coronary artery disease risk. Exercise also promotes the efficiency of insulin-mediated uptake of glucose into cells.) **(Papp and John, 2009**). Chromium and GTF are used in the treatment of both hypoglycemia and diabetes mellitus which were two problems of blood sugar utilization and metabolism. Also it has been used along with niacin (also a part of GTF) in the treatment of high blood cholesterol. So, preventing chromium deficiency is the key here **(Heimbach and Anderson, 2005).**

Therefore the aim of the present study is to determine the levels of lead, copper, zinc and chromium in edible chicken giblets.

MATERIAL AND METHODS

Collection of samples:

A total of 60 random samples of edible chicken giblets represented by liver, gizzard and heart (20 of each) were collected randomly from different markets for determination of their contents of lead, copper, zinc and chromium.

1- Washing procedure (Lars, 2003):

The test tubes, polyethylene tubes and glassware were soaked in water and soup for 2 hours then rinsed several times with tap water. Moreover, the glass was rinsed once with distilled water, once with cleaning mixture (520ml deionized water, 200ml concentrated HCL and 80ml H_2O_2) and once with washing acid (10% H N03). Finally, they were washed with deionized water and then air-dried in incubator away from contamination or dust.

2- Digestion procedure: (Falandyaz, 1991):One gram of each sample was processed by a sharp scalpel in a screw capped tube and 5ml of the digestion mixture (60ml nitric acid and 40ml perchloric acid) were added. The tubes were tightly closed and the contents were vigorously shaken and allowed to stand overnight. Further the tubes were heated for 3 hours in water bath at 70^{o}c to ensure complete digestion of the samples. The digestion tubes were vigorously shaken at 30 minutes intervals during the heating period. Therefore, the tubes were cooled at room temperature and then diluted with 5ml deionized water and filtered through Wattman filter paper No. 42. The filtrate was collected in polyethylene tubes and kept at room temperature until analysis.

3- Preparing of blank and standard solutions (Cang et al., 2004):

Blanks and standards were prepared in the same manner as for wet digestion and by using the same chemicals. Blank tubes were used to determine the heavy metal contamination that may be present in the chemicals used for wet digestion. While serial standard solutions were prepared for lead, copper, zinc and chromium by using pure certified metal standard at ideal adequate strength.

4- Determination:

The Concentrations of heavy metals in the prepared solutions were determined by using Flame Atomic Absorption Spectrophotometer **(Perkin Elmer mode, Spectra –AA10, USA).** Accurately, the apparatus was adjusted at wave lengths of 217.0nm for lead, 324.8nm for copper, 213.9nm for zinc and 246.4nm for chromium. Absorbance and concentration of each metal were recorded on the digital scale of the apparatus. The obtained results of lead, copper, zinc and chromium levels in the examined samples were calculated as mg/kg on wet weight.

RESULTS

Table (1): Statistical analytical results of lead, copper, zinc and chromium in examined chicken liver samples. n = 20

Element	Min	Max	Mean ±SE
Lead	0.09	0.83	0.47 ±0.08
Copper	1.6	9.15	5.13 ±0.59
Zinc	2.03	11.67	5.27 ±0.59
Chromium	0.09	0.69	0.38 ±0.08

Table (2): Statistical analytical results of lead, copper, zinc and chromium in examined chicken gizzard samples. n = 20

Elements	Min	Max	Mean ± SE
Lead	0.05	0.61	0.24 ± 0.06
Copper	1.18	6.68	3.57 ± 0.45
Zinc	1.33	7.85	3.15 ± 0.39
Chromium	0.09	0.47	0.22 ± 0.06

Table (3): Statistical analytical results of lead, copper, zinc and chromium in examined chicken heart samples n = 20

Elements	Min	Max	Mean ± SE
Lead	0.02	0.17	0.09 ± 0.024
Copper	0.47	3.9	1.77 ± 0.26
Zinc	1.1	4.94	2.23 ± 0.26
Chromium	0	0	0

Standard levels of lead, copper, zinc and chromium recommended by WHO and ES:

Element	WHO (1984)	ES (1993)
Lead	0.05	0.1
Copper	1	1
Zinc	20	20
Chromium	0.4	0.4

DISCUSSION

From the results in Table (1) it is evident that the concentrations of heavy metals in examined chicken liver samples ranged from 0.09 to 0.83, with a mean value 0.47 ± 0.08 mg/kg for lead, 1.6 to 9.15 with a mean value 5.13 ± 0.59 mg/kg for copper, 2.03 to 11.67, with a mean value 5.27 ±0.59 mg/kg for zinc and 0.09 to 0.69, with a mean value 0.38 ± 0.08 mg/kg for chromium, respectively.

Also results obtained in Table (2) indicated that the concentrations of heavy metals in the examined chicken gizzard samples ranged from 0.05 to 0.61, with a mean value 0.24 ± 0.06 mg/kg for lead, 1.18 to 6.68, with a mean value 3.57 ± 0.45 mg/kg for copper, 1.33 to7.85, with a mean value 3.15 ±0.39 mg/kg for zinc and 0.09 to 0.47, with a mean value 0.22 ±0.06 mg/kg for chromium.

Moreover, the results recorded in Table (3) showed that, the concentrations of heavy metals in examined chicken heart samples ranged from 0.02 to 0.17, with mean a value 0.09 ± 0.024 mg/kg for lead, 0.47 to 3.9, with a mean value 1.77 ±0.26 mg/kg for copper, 1.1 to 4.94, with a mean value 2.23 ± 0.26 mg/kg for zinc, while chromium could not be detected in all examined heart samples.

According to guideline values of **(WHO,1984)** for permissible limits of lead whish is (0.05) and the **(Egyptian Standard, 1993)** whish is (0.1) ,The obtained results in Table (1) indicated that, the mean values of lead in liver and gizzard samples were exceeded the guideline values of **(WHO,1984)** and also the **(Egyptian Standard,1993)**, respectively. While in the examined heart samples the lead concentration was nearly similar to the value recorded by **(WHO, 1984)** but it is smaller than the value recorded by **(Egyptian Standard, 1993).** Lead is recognized as toxic substance which accumulates in the body due to its low rate of elimination. The classic symptoms of lead poisoning are colic, anemia, encephalopathy(**Karri et al., 2008)** .Acute poisoning of lead may result in leg cramp, muscular weakness, CNS depression, coma and death within 1-2 days**.** In women lead poisoning leads to abnormal ovarian cycles, menstrual disorders, abortion, still birth, fetal macrocephaly **(Needleman et al., 1984),**while in men it affect male gonads and lead to abnormalities in sperms, impotence and sterility **(Needleman ,2004).**

Regarding to the guideline valued of **(WHO, 1984)** and **(Egyptian Standard, 1993),** for the permissible limits of copper whish is (1). The obtained results in Tables (1) and (2) showed that the mean value of copper in the examined liver and gizzard chicken samples were exceeded the guideline of **(WHO, 1984)** and **(Egyptian Standard, 1993).**While in Table (3), the examined heart chicken samples were nearly similar to the copper level recommended by **(WHO, 1984).**Although copper is known to be essential of low concentration, it is toxic at high levels. So excessive dose of copper may lead to Wilson's disease which manifested by liver cirrhosis, ascitis, oedema and hepatic failure, in addition to destruction of nerve cells**.(Copper- organization, 2009**).Also copper toxicity can result from ingesting or absorbing excess copper and leads to self-limited gastroenteritis with nausea, vomiting, and diarrhea**.(Merk, 2008).** More severe toxicity results from ingestion of gram quantities of a copper salt (eg, copper sulfate) or from absorption of large amounts through the skin, hemolytic anemia and anuria can result and may be fatal**. (Cornell University, 2008).**Also,copper poisoning cause golden brown ring of accumulated copper on cornea of eye, While a sign of copper deficiency is osteoporosis**.(Gossel and Briker, 1990).**

Regarding to the guideline value of(**WHO,1984)** for the permissible limit of zinc which is 20mg/kg.The obtained results in Table (1),(2),(3) for the mean value of zinc in chicken liver, gizzard and heart samples were not exceeded the guideline of (**WHO,1984)**. Zinc toxicity can occur in both acute and chronic forms. Acute adverse effects of high zinc intake include nausea, vomiting, loss of appetite, abdominal cramps, diarrhea, and headaches **(Institute of Medicine, Food and Nutrition Board, 2001).**One case report cited severe nausea and vomiting within 30 minutes of ingesting 4 g of zinc gluconate (570 mg elemental zinc), intakes of 150–450 mg of zinc per day have been associated with such chronic effects as low copper status, altered iron function, reduced immune function, and reduced levels of high-density lipoproteins **(Johnson et al., 2007).** Reductions in a copper-containing enzyme, a marker of copper status, have been reported with even moderately high zinc intakes of approximately 60 mg/day for up to 10 weeks **(Institute of Medicine, Food and Nutrition Board, 2001).** The doses of zinc used in some studies (80 mg per day of zinc in the form of zinc oxide for 6.3 years, on average) have been associated with a significant increase in hospitalizations for genitourinary causes, raising the possibility that chronically high intakes of zinc adversely affect some aspects of urinary physiology (**Johnson et al,2007).**

On the other hand the chromium permissible limits showed by **food stuffs cosmetics and Disinfectant Act (1972)** is (0.4). The data in Table (1) and (2) revealed that the mean values 0f chromium concentration in the examined liver and gizzard samples not exceeded the guideline of **FSCDA**.While chromium level could not be detected in the examined chicken heart samples. Because of the low absorption and high excretion rates of chromium, toxicity is not at all common in humans, especially with the usual forms of chromium used for supplementation. The amount of chromium that would cause toxicity is estimated to be much more than the amount commonly supplied in supplements**. (Barceloux et al., 1999 and Vincent &John, 2003).** Even mild deficiencies of chromium can produce symptoms other than problems in blood sugar metabolism, such as anxiety or fatigue. Abnormal cholesterol metabolism and increased progress of atherosclerosis are associated with chromium deficiency, and deficiency may also cause decreased growth in young people and slower healing time after injuries or surgery, the low chromium levels seen in the United States are associated with a higher incidence of diabetes and arteriosclerosis. Further research is needed to confirm these associations and to determine whether correcting the chromium deficiency would actually reduce the incidence of these diseases. (**Katz et al., 1992 and Dayan** &**Paine, 2001**).

Furthermore, the continuous consumption of chicken giblets may constitute at times, a public health hazard through progressive accumulation of these elements inside human body. Therefore, performing periodical surveys on chicken giblets for measuring the pollutants to determine their concentration in addition to education the consumers with these pollutants, their sources, health hazards and control which should be carried out.

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