Animal Health Research Institute, Alexandria.

POLLUTION OF SOME POULTRY MEAT PRODUCTS WITH HEAVY METALS IN ALEXANDRIA GOVERNORATE

(With 2 Tables)

By

A.S. AIAD; SWSAN M. ARAFA and MERVAT K.I.

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تلوث بعض منتجات لحوم الدواجن بالمعادن الثقيلة في محافظة الإسكندرية

احمد صلاح الدين عياد ، سوسن محمد عرفة ، مرفت كمال ابراهيم

لقد أجريت هذه الدراسة على بعض منتجات الدواجن وتشمل اللانشون والناجيتس وصدور الدواجن وقد تم جمع العينات من أسواق الأسكندرية المختلفة ثم تم هضم العينات باستخدام الأحماض المركزة وذلك لتقدير مستويات بعض انواع المعادن الثقيلة (الكادميوم والرصاص والزئبق والنحاس والنيكل والزنك) وقد أسفرت الدراسة النتائج الآتية: - متوسط تركيز الكادميوم ٠,٠٥ (جزء فى المليون) بمعدل يتراوح من٠,٠٠ الى ٠,٠٩ فى لانشون الدجاج و٠,٠٤٧ (جزء فى المليون) بمعدل يتراوح من ٠,٠٠١ الى٠,٠٨٢ فى الناجيتس ٠,٠٥(جزء فى المليون) بمعدل يتراوح من ٠,٠١ الى ٠,١ فى صدور الدواجن على التوالى. - متوسط تركيز الرصاص ٠,٢٦٦ (جزء فى المليون) بمعدل يتراوح من ٠,٠٠ الى٠,٤٨٥ فى لانشون الدجاج و٠,٠٨٨ (جزء فى المليون) بمعدل يتراوح من ٠,٠٠ الى ٠,١٤٤ فى الناجيتس و٠,٠٥٧ (جزء فى المليون) بمعدل يتراوح من ٠,٠٠ الى ٠,١١ فى صدور الدواجن على التوالى. - متوسط تركيز الزئبق ٠,٠٥١ (جزء فى المليون) بمعدل يتراوح بين ٠,٠١٣ الى٠,١٠٩ فى لانشون الدجاج و ٠,٠٥٩ (جزء فى المليون) بمعدل يتراوح من ٠,٠٠ الى٠,٣٠١ فى الناجيتس و ٠,٠٥٣(جزء فى المليون) بمعدل يتراوح من ٠,٠١١ الى ٠,٠٩٥ فى صدور الدواجن على التوالى. - متوسط تركيز النحاس ٠,٠٨٥ (جزء فى المليون) بمعدل يتراوح من ٠,٠٣٨ الى ٠,١١٦ فى لانشون الدجاج و٠,١٠٨ (جزء فى المليون) بمعدل يتراوح من٠,٠٧ الى٠,١٣٥ فى الناجيتس و ٠,٠٥٨ (جزء فى المليون) بمعدل يتراوح من ٠,٠٠٦٣ الى ٠,٠٦٧ فى صدور الدواجن على التوالى. - متوسط تركيز النيكل ٠,٠٩٤ (جزء فى المليون) بمعدل يتراوح من ٠,٠٠٤ الى ٠,١٨٢ فى لانشون الدجاج و ٠,١٤٨ (جزء فى المليون) بمعدل يتراوح من ٠,٠٠ الى٠,٢١٤ فى الناجيتس و ٠,٠٩٣ (جزء فى المليون) بمعدل يتراوح من ٠,٠٠ الى ٠,١٦٢ فى صدور الدواجن على التوالى. - متوسط تركيز الزنك ٠,٣٢٠ (جزء فى المليون) بمعدل يتراوح من ٠,٢٦٣ الى٠,٣٩٤ فى لانشون الدجاج و ٠,٣٦٥ (جزء فى المليون) بمعدل يتراوح من ٠,١٦٢ الى ٠,٥٣٥ فى الناجيتس و ٠,٢٨٩ (جزء فى المليون) بمعدل يتراوح من ٠,٢٢٧ الى ٠,٣٤٨ فى صدور الدواجن على التوالى. كما أوضحت النتائج أن ٢٠% من عينات اللانشون و ١٠% من عينات الناجيتس كانت تحتوى على نسب أعلي من

الحدود المسموح بها طبقا للمواصفة القياسية المصرية بالنسبة للكادميوم بينما كانت جميع عينات صدور الدواجن فى الحدود المسموح بها وأن ٥٠% من عينات اللانشون و ١٥% من عينات الناجيتس و ٥ % من عينات صدور الدواجن احتوت على نسب أعلي من الحدود المسموح بها من الرصاص طبقا للمواصفة القياسية المصرية كما أسفرت النتائج أن نسب الزئبق والنحاس والنيكل والزنك كانت في الحدود المسموح بها فى جميع العينات طبقا للمواصفة القياسية المصرية وقد تم مناقشة النتائج وخطورة تواجد هذه المعادن على الصحة العامة للإنسان.

SUMMARY

A total of 75 random samples of poultry products (25 each of luncheon, nuggets, and breast chicken fillet) were collected from different supermarkets in Alexandria Governorate. Samples were analyzed for the levels of cadmium (Cd), lead (Pb), mercury (Hg), copper (Cu), nickel (Ni), and zinc (Zn) by using Atomic absorption spectrophotometer. Results revealed that the mean cadmium levels in the examined luncheon, nuggets and breast chicken fillet were 0.5 ± 0.005, 0.47 ± 0.013, and 0.050 ± 0.006 ppm, respectively. The mean lead levels were 0.266 ±0.037, 0.088 ± 0.012 and 0.057 ± 0.005 ppm, in the examined samples respectively, while the mean Hg levels in the examined samples were 0.051 ± 0.006, 0.059 ± 0.035 and 0.053 ± 0.006 ppm, respectively. At the same time the mean Cu, Ni, Zn levels were 0.085 ± 0.005, 0.108 ± 0.004 and 0.058 ± 0.0002 ppm, 0.094 ±0.013, 0.148 ± 0.009 and 0.093 ± 0.019 ppm, and 0.320 ± 0.009, 0.365 ± 0.035 and 0.289 ± 0.020 ppm, in the examined samples of luncheon, nuggets and breast chicken fillet, respectively. Our results revealed that 20% of luncheon samples and 10% of nuggets samples exceeded the permissible limits for cadmium while breast chicken fillet comply with the permissible limits. At the same time 50% of luncheon samples, 15% of nuggets and 5% of breast chicken fillet exceeded the permissible limits for lead. It was reported that the mean concentration of Hg, Cu, Ni, Zn in all the examined samples were comply with the Egyptian standards. Public health hazard and the preventive measures intended for minimizing the residues of heavy metals in poultry products were discussed.

Key words: *Heavy metals, luncheon, nuggets, and breast chicken fillet*

INTRODUCTION

Environmental pollution with heavy metals is considered to be one of the most important problems confronting human and animal health. Lead, cadmium, copper and zinc are among the most important of these elements. Industrial and agricultural processes have resulted in an increased concentration of heavy metals in air, water, and soil; these metals are taken their way into food chain (Wail, 2002). Heavy metals contaminants of air or ingestion of contaminated water and feed of plants or animal origin resulted in residues in poultry meat. (Leonzio and Mossi, 1989). The presence of heavy metals in chicken, even in low level can lead to considerable concentration in human body. Metals that cannot be metabolized (as cadmium and lead) persist in body and exert toxic effect in form of cellular disturbance or clinical manifestation (Friberg and Elinder, 1988). Based on consideration of usage, toxicity and environmental occurrence, much national and international health organization accorded first priority in their programs on the toxic metals as pb, Cd and Hg (Jelinek, 1985).

Studies confirm that heavy metals can directly influence behavior by impairing mental and neurological function; dysfunction in the blood, circulating system, detoxification pathway (colon, liver, kidney, skin, endocrine system and immune system). In addition they can increase allergic reaction and cause genetic mutation (Capark and katalenic, 2001). Cadmium is accumulative toxic agent with biological half life of several years. The cadmium burden of the body increase with age and the main sites of deposition are liver and kidney. It is also a principal toxic metal, where it disturbs Zinc, Copper, and other metals and is considered as a major contributor to thyroid disease (Cussads, 1995). Cadmium has a number of industrial applications it is used mostly in metal plating, pigments, batteries and plastics however for most people the primary source of Cd exposure is food. Cadmium in air, drinking water and food has the potential to affect the health of whole populations, but mainly those who live in industrial regions (WHO 1994). Acute exposure to cadmium cause hypotension, hemolytic anemia, cardiovascular collapse while chronic exposure result in jaundice in human (Gassel and Bricker, 1990).

Lead is used in many industrial processes, lead paints, lead gasoline and lead arrevate contains significant quantities of lead. Absorbed lead accumulates in tissues of poultry and animals and mainly stored in the liver (Daoud and Rashed, 2002). In human, high lead toxicity has toxic effect on several body systems includes acute encephalopathy, characterized by irritability, visual disturbance, abdominal pain or lead colic, vomiting, coma, convulsions and death. It is accumulative poison; it has hematological effect due to the inhibition of hemoglobin synthesis and shortening life span of circulating erythrocytes. These may result in anemia and microcythaemia (Alberti and Fidanz, 2002). Exposure to lead even at very low levels is highly toxic, where it causes a neurotoxic effects associated with low levels of exposure such as lowered intelligent, behavioral problems, poor performance in school (Bakoili, *et al.,* 1995).

Copper and zinc are essential elements and when given in excess are toxic to man and animal (Pond, 1975). Copper is an essential element for man and animals. It is required for normal biological activity for many enzymes. Excess amount of copper in food gives rise to outbreak of copper poisoning. Most cases of acute poisoning were caused by accidental administration of large quantities of soluble copper salts and contaminated plants with fungicidal sprays containing over doses with copper.

Zinc is an essential element for human as being involved in protein synthesis and as a constituent of many enzymes. It is a relatively non toxic to human. High levels of zinc in foods may be toxic to the human, where it causes deficiencies in metals like copper (Falandys, 1991). Because of the possible increase of heavy metals in processed foods and the toxicity of these metals on human, therefore their presence in food should be carefully checked in order to prevent possible toxicological risks, so the specific objective of this study was to determine of heavy metal residues in some poultry products.

MATERIALS and METHODS

A total of 75 samples of locally produced poultry meat products were collected from Alexandria supermarkets (25 samples each of luncheon, nuggets and breast chicken fillet).

1. Heavy metals analysis:

Heavy metals including cadmium, lead, copper, nickel and zinc were determined in poultry products using atomic absorption spectrophotometer (PERKIN, ELMER2380) according to Richard and Rubinshapiro, (1986). In case of mercury, the analysis was conducted according to Honway and Donny (1985) using flameless atomic absorption spectrophotometer.

2. Statistical analysis:-

Data were analyzed for means, standard deviation and standard errors. Luncheon, nuggets ands breast chicken fillet were compared according to the method of least significant difference (LSD) using F-test. The level of significance for all samples was set at $p<0.05$ (Steel and Torrie, 1980)

RESULTS

The obtained results in this study are summarized in Tables 1, 2.

Table 1: Statistical analytical results of heavy metal levels (ppm) in poultry meat products

Poultry products	Heavy metal levels (p.p.m)																	
	Cadmium (Cd)			Lead (Pb)			Mercury (Hg)			Copper (Cu)			Nickel (Ni)			Zinc (Zn)		
	Min.	Max.	Mean ± S.E.	Min.	Max.	Mean ±S.E.	Min.	Max.	Mean ±S.E.	Min.	Max.	Mean ±S.E.	Min.	Max.	Mean ±S.E.	Min.	Max.	Mean ±S.E.
Luncheon	0.00	0.09	0.05 ± 0.005	0.0	0.485	0.266* ±0.037	0.013	0.109	0.051 ±0.006	0.038	0.116	0.085 ±0.005	0.004	0.182	0.094 ±0.013	0.263	0.394	0.320 ±0.009
Nuggets	0.001	0.082	0.047 ± 0.013	0.0	0.144	0.088 ±0.012	0.000	0.301	0.059 ±0.035	0.07	0.135	0.108* ±0.004	0.0	0.214	0.148 ±0.009	0.162	0.535	0.365* ±0.035
Breast chicken Fillet	0.01	0.10	0.050± 0.006	0.0	0.11	0.057 ±0.005	0.011	0.095	0.053 ±0.006	0.0063	0.067	0.058 ±0.0002	0.0	0.162	0.093 ±0.019	0.227	0.348	0.289 ±0.020

* Differences between lead, copper and zinc mean concentration were significant at $P < 0.05$

Table 2: Correlation as described by Pearson's Covelation coefficient (η) between metals (Cd, Pb, Hg, Cu, Ni, Zn) in the examined poultry meat products

Heavy metals	Poultry products		
	Luncheon	Nuggets	Breast chicken fillet
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.
Cadmium (Cd)	0.050±0.025	0.047±0.067	0.050±0.028
Lead (Pb)	0.266±0.186	0.088±0.061	0.057±0.026
Mercury (Hg)	0.051±0.028	0.059±0.175	0.053±0.028
Copper (Cu)	0.085±0.026	0.108±0.020	0.058±0.001
Nickel (Ni)	0.094±0.067	0.148±0.046	0.093±0.041
Zinc (Zn)	0.320±0.044	0.365±0.176	0.289±0.101
Correlation coefficient (r)	0.6630	0.9990	0.996

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DISCUSSION

Heavy metals are persistent type of pollutants and cannot be destroyed by heat treatment, so that, their persistence enhances their potential to reach and affect the human being (Levensen and Bormand, 1988).

Table (1) presents the statistical analytical results of heavy metals in poultry products. It was found that all the examined poultry products (luncheon, nuggets and breast chicken fillet) showed nearly similar results of cadmium levels (0.050 ppm, 0.047 ppm, 0.050 ppm), respectively. In case of lead, luncheon had the highest mean concentration (0.266 ppm) followed by nuggets (0.088 ppm) and the breast chicken fillet (0.057 ppm), respectively. Concerning mercury and nickel all the examined samples showed nearly similar results. In case of copper nuggets had the highest mean concentration (0.108 ppm) while the breast chicken fillet showed the lowest (0.058 ppm). Regarding zinc, nuggets had the highest mean concentration (0.365 ppm) while breast chicken fillet showed the lowest (0.289 ppm). There was a significant difference in the mean concentration of Pb between all the examined samples at the same time, there was a significant difference in mean values of copper, Zinc between nuggets and breast chicken fillet samples, respectively. Egyptian organization for standardization (EOS, 1993) stated that the maximum permissible limits of cadmium, lead, mercury, copper and zinc in luncheon, nuggets and breast chicken fillet must be not more than 0.05, 0.1, 0.5, 3.5, and 40 ppm, respectively.

It was reported that heavy metal concentrations in muscles of chickens collected from Assiut governorate were 0.040ppm, 0.016 ppm, 4.951 ppm, 0.343 ppm, 16.360 ppm for Pb, Cd, Hg, Cu, Zn, respectively (Sharkawy *et al.,* 2002). While, Hanna *et al.,* (2004) found that the mean values of heavy metals in thigh muscles of slaughtered broilers collected from local market in Kalubya governorate were 0.280 ± 0.006, 0.196 ± 0.024, and 1.721 ± 0.226 ppm for Pb, Cd, and Cu, respectively. Also, Abdeen and Arafa, (2007) reported that the mean heavy metal concentrations in muscle tissue of broilers collected from Nubaria area were 1.2 ±0.07, 2.9 ± 0.31, 1.13 ± 0.11 and 7.1 ± 0.51 ppm for Cd, Pb, Cu, and Zn, respectively.

Tissue cadmium concentration in animals is closely related to cadmium levels in feed stuffs, the dose of cadmium and the duration of cadmium load (Bokori *et al.,* 1995).

The mean values of copper, zinc, cadmium, mercury and lead concentrations in muscles of chicken and hens collected from the northern part of Poland during 1987 ranged from 0.52-7.3 mg/kg, 5.7-40 mg/kg, 10-35 mg/kg, less than 5.5 µg/kg, less than 1-3 µg /kg, less than 10-20 µg /kg, respectively (Falandys, 1991).

It was reported that chicken muscle tissue contained the lowest level of Pb (280 ppb) collected from a small farm flock in Iowa. Lead contamination of edible chicken tissues represents a potential public health hazard, especially to children repeatedly consuming eggs from contaminated family- owned flock (Tampel *et al.*, 2003).

The mean cadmium content found in poultry tissue samples collected from Finland was low (< 0.001mg/kg). The decrease is due to low Cd emission in Finland. Furthermore, feed composition can influence the retention of trace elements (Magdalena and Beat, 2002).

Heavy metals emitted by industries, traffic, municipal wastes and hazardous wastes sites have resulted in a steady rise in contamination of ground water (Yong *et al.,* 1989). Lead may also contaminate animal foods (mainly cereals and grains). Soil lead is taken up by root vegetable and atmospheric lead may fall on to leafy vegetables (Mushak *et al.,* 1989).

The high concentrations of nickel were in canned food suggesting a contribution from food processing equipment (Peshin *et al.*, 2002).

Trace elements in manure that are of environmental concern include arsenic, copper, selenium, zinc, cadmium, molybdenum, nickel, lead, iron, manganese. Arsenic, copper, selenium and zinc are often added to animal feed as growth stimulants or biocides. Poultry farms may use water from municipal sources (Ponds, wells, lakes, rainfall. catchments and springs), because of its nature of hydrogen bonding, water is an excellent solvent for both inorganic and organic substances, for this reason water is an ideal medium for proliferation and distribution of harmful components such as chemical elements (EPA, 2001).

Our results revealed that cadmium 20% of luncheon samples and 10% of nuggets samples exceed the permissible limits while breast chicken fillet comply with the permissible limits. At the same time 50% of luncheon samples, 15% of nuggets and 5% of breast chicken fillet exceeded the permissible limits for lead. It was reported that mean concentration of Hg, Cu, Ni, Zn in all the examined samples comply with EOS, (1993).

It was reported that Cu, Zn were below the permissible limit in all the examined samples of chicken collected from Nubaria area (Abdeen and Arafa, 2007).

It was found that all poultry tissue samples collected from six regions in Solvenia from 1997 to 1999 had Cd, Pb and Hg, levels within the Slovenia standards (Jersink and Doganoc, 2003). It was reported that the mean concentration of cadmium measured in poultry breast and leg muscles were relatively low 0.0187mg/kg, 0.021 mg/kg. respectively. Concentrations of cadmium were slightly lower in breast than in leg muscle (Breackman *et al.,* 1997). The cadmium mean concentration in poultry meat was found to be 0.009 mg/kg central data base from anon contaminated area of Slovak republic. Absorption and accumulation of Cd in tissue seems to be determined by a wide range of factors Nutrition, vitamin status age, and sex. (Soko *et al.,* 1998). According to Falandys *et al.,* (1994) the mean concentration of cadmium in the muscles of poultry in Poland was 0.038mg/kg. Low lead residual levels in tissue of birds may be attributed to the collection of birds from areas subjected to low environmental pollution. But high concentration may be attributed to the presence of high lead levels in the feed as well as drinking water (Demirbos, 1999).

Mercury occurs naturally in the environment, in low levels. It for most part comes from industrial sources (Clarkson, 2002). It was reported that canned poultry products collected from different supermarkets in Alexandria, showed mean levels of cadmium, lead, mercury, copper, nickel, and zinc of 0.004, 0.116, 0.318, 0.141, 0.019 ppm, respectively (Ibrahim and Arafa, 2003).

Lead is a significant contaminant that may be indirectly added to processed foods even if they are packed in non lead soldered cans (Kula and Lasto, 1986).

Table (2) showed the correlation between heavy metals Cd, Pb, Hg, Cu, Ni, and Zn in the examined poultry products. It was clear that, there was a strong correlation between the studied heavy metals in nuggets(r = 0.9990), followed by breast chicken fillet (r = 0.996) and then luncheon(r =0.6630), respectively. During recent years, the importance of Hg in the food chain has become better understood. Inorganic, organic mercury derivatives are arising as effluent from industrial processes and converted in the lakes and rivers into soluble methyl mercury. This is carried down to the sea, where it is taken by man and animal through drinking water (Sharkawy, and Mohamed, 2003).

The preventive measures intended for minimizing the residues of heavy metals in poultry meat products are of significant concern which include avoid contamination of water sources with industrial waste products, control the use of pesticides and fungicide as well as sewage sludge to reduce the pollution, prevent rearing of poultry near high traffic density and periodical examination of water sources for farms.

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