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LEVELS OF LEAD AND CADMIUM RESIDUES IN TISSUES OF BOVINE SLAUGHTERED IN PORT-SAID GOVERNORATE

(With 5 Tables)

By

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مستويات بقايا الرصاص والكاديوم في أنسجة الأبقار المذبوحة في محافظة بورسعيد

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في دراسة لتحديد مستويات بقايا الرصاص والكاديوم في أنسجة الأبقار المذبوحة تم جمع 210 عينة من الكلي، الكبد، الرئة، الطحال، الغدة الليمفاوية للمساريقا، الجزء العضلي من الحجاب الحاجز، والمخ بواقع 30 من كل نوع لثلاثين من العجول البقرية الصالحة للاستهلاك الادمي والتي تم جمعها عشوائيا من مجزر مدينة بورسعيد. اظهرت النتائج أن نسبة وجود الرصاص والكاديوم في العينات كانت 100% ، وبلغ متوسط تركيز الرصاص في الكلي، الكبد، الرئة، الطحال، الغدة الليمفاوية للمساريقا، الجزء العضلي من الحجاب الحاجز، والمخ 1.674 ، 0.919، 2.206 ، 2.681 ، 2.818 ، 1.641 ، و 1.201 ميكرو جرام/جرام من الوزن الطازج علي التوالي. بينما كان متوسط نسبة وجود الكاديوم 0.611 ، 0.564 ، 0.773، 0.657، 0.645، 0.779 ، 0.488 ميكروجرام/جرام وزن طازج علي التوالي. وبمقارنة النتائج بالمواصفات القياسية المصرية للمعادن الثقيلة في أنسجة الأبقار الصالحة للاستهلاك الآدمي كانت هناك زيادة كبيرة في كل العينات عن الحد المسموح به لمستوي الرصاص طبقا للمواصفات القياسية المصرية. بينما كانت نتائج عنصر الكاديوم في أنسجة الأبقار الصالحة للاستهلاك الآدمي تقترب نسبيا من الحد المسموح به ووجد 46 (21,904%) عينة من إجمالي العينات تزيد عن الحد المسموح به لمستوي الكاديوم طبقا للمواصفات القياسية المصرية. تم مناقشة تاثير مستوي متبقيات الرصاص والكاديوم علي الصحة العامة.

SUMMARY

Two hundred and ten samples from bovine kidneys, livers, lungs, spleens, mesenteric lymph nodes, muscular portions of diaphragm and brains were collected randomly from 30 fit bovine carcasses for human consumption from Port-Said abattoirs. Lead and cadmium residues were analyzed. Lead and cadmium were detected in 100% of the specimens. Mean lead values in the examined samples obtained from kidney, liver, lung, spleen, mesenteric lymph node, muscular portion of diaphragm and brain for bovine were 1.674, 0.919, 2.206, 2.681, 2.818, 1.641 and 1.201 µg/g wet weight respectively. While mean cadmium values in the examined samples were 0.611, 0.564; 0.773; 0.657; 0.645; 0.779 and 0.488 µg/g on the basis of wet weight respectively. All examined samples 210 (100%) exceeded the recommended level of lead established by E.O.S.Q.C while 46 (21.904%) among the total samples could be considered unsuitable for human consumption entirely as it approximate the critical levels of cadmium established by E.O.S.Q.C. The effects of lead and cadmium on the public health were discussed.

Key words: *Lead, cadmium, offal, bovine carcases.*

INTRODUCTION

From the public health stand point of view attention must be paid, not only to the study of the nutritional benefits of meat and their products, but also to the safety aspects, especially those concerns with the presence of harmful pollutants substances to human health.

Heavy metals make up one of the most important groups of pollutants. From the point of food analyst, heavy metals which are referred to the inorganic elements, metallic in nature had a hazardous effect even at relatively low concentration. Moreover, not broken down at all or may chelated over a long time scale to become permanent additions to the environment and animal consequently human tissues. These heavy metals are not needed as structural components of organs and tissues, not constituents of body fluids and not a constituent or activators of enzymes system in body except traces of arsenic, which are needed in a very low concentration (Royal Commission on Environmental Pollution, 1979).

Contamination of animal tissues by heavy metals is arisen mainly from the contamination of animal requirements from feed, water, air beside the accidental addition which can be associated with soils

naturally high in these elements, environmental pollution from local industry, feeding grain treated with the toxic metals, and the use of impure chemicals (Hecht, 1990). Thus heavy metals enter food chain and lead to unwanted residues in food animals. These residues have a pharmacological action and conversion products, then are transmitted to the target organs in the animal body which are mainly the edible offal of the slaughtered food animals (Gracey and Collins, 1992).

These heavy metals are undesirable and produce no lesion in animal tissues that can be observed post-mortem except in heavy intoxication (Royal Commission on Environmental Pollution, 1979).

The absorbed lead in animal had a tendency to accumulate and produced pathological changes in bone, liver, kidney (National Academy of Science, 1972) and in central nervous system (Wells *et al.*, 1975). These changes include fatty infiltration, necrotic foci and billiary cirrhosis in liver (Gouda, *et al.*, 1985; Gracy and Collins, 1992), chronic diffuse glomerulonephritis with edema (Gracy and Collins, 1992; Thiel, 1994) and fibrosis (Schraishuhn *et al.*, 1992) of kidney. Also gastroenteritis, epicardial and endocardial hemorrhages and pulmonary congestion (Gracy and Collins, 1992) has been occurred. On the other hand cadmium intoxication in animal has characterized by an increase in the weight of spleen and thymus, thyroid and adrenal gland with an increasing in the incidence of the pyelonephritis, anemia and bone demineralization (Glaser and Muller-Peddingghaus, 1978; Rotkiewiez *et al.*, 1979). Hyperemia, edema, degenerative changes in the heart, muscle and lung and thickening of the keratinized layer of rumen reticulum and omasium were recorded as a signs of cadmium intoxication (Rotkiewiez *et al.*, 1979).

Although certain amounts of lead and cadmium can be tolerated by the human being, they are absolutely toxic at certain level. Excessive intake of heavy metals in his food had led to many cases of intoxication, ranged between the gastrointestinal disturbance to liver and kidney dysfunction and lung carcinoma (Gracey and Collins, 1992). Also lead causes encephalopathy in children usually followed by permanent CNS damage with signs of impaired neurobehavioral, cognitive and electrophysiological deficits (Carl, 1991; WHO, 1995). While in adult avitaminosis, loss of weight and anemia (WHO, 1980; Carl, 1991), hepatocellular injury and dysfunction of the liver (Denuman *et al.*, 1983; Carl, 1991), kidney damage, gastrointestinal irritation (Carl, 1991), tumor formation (Carrington *et al.*, 1993) and cardiovascular problems with hypertension (Staessen *et al.* (1996) has been recorded. Cadmium

intoxication in human result in renal damage and dystrophic changes associated with hypercalcuria, glucosuria, proteinuria and aminoaciduria with hypertension (Ragan and Mast, 1990; Carl, 1991; Gracey and Colins, 1992) and itia-itia disease (FAO/WHO, 1972). Also a dystrophic change in the liver and testis (Gruenwedel, 1990; Gracey and Colins, 1992) associate with anemia (Robards and Worsfold, 1991) has been reported.

The aim of the present study is to determine the lead and cadmium levels in certain bovine edible offal (kidney, liver, lung, spleen, mesenteric lymph node, diaphragm and brain) in order to ensure the safety of the consumer and direct the attention to their public health significance

MATERIALS and METHODS

1- Collection of the samples:

A total of 210 random samples of various bovine edible offal (30 each of kidney, liver, lung, spleen, mesenteric lymph node, part of the muscular portion of the diaphragm, and brain) were selected from 30 of apparently healthy and fit for human consumption bovine carcasses from Port- Said abattoir. Each individual sample was placed separately into plastic bag thoroughly identified and delivered to the laboratory, where they were stored at (-20˚c) until lead and cadmium residues analyzed.

2- Laboratory technique:

2- 1-Preparation of tissues

The tissues were prepared and freed from extraneous fat, tendon and major blood vessels according to van derVeen and Vreman (1986).

2- 2-Extraction of residual lead and cadmium:

One gram of the sample was placed in a clean and dry 20 ml Teflon tube with screw capped and treated with 5 ml of nitric-perchloric acid mixture (4:1 v/v). The samples were left to be stand for the cold digestion overnight, then the samples were heated in water bath at 70 $^{\circ}$C for 3 hr. The heat turned off and the screw capped was unbound, just to crimp on the mouth of the tube to expel nitrous gases, tubes allowed to cool.

The digest was diluted with deionized water where its volume adjusted to 25 ml in a volumetric flask. The obtained mixture (25ml) was filtrated through a glass funnel containing Whatman filter paper No.1.

For each sample the obtained clear filtrate was divided between two clean dry stopper bottles and preserved at refrigerator until the time

of assessment of the metal concentration according to Morcombe *et al.* (1994) and Atta (1995).

2-3- Assessment of residue by atomic absorption spectrophotometer:

The two clear filtrate of the same sample was investigated for the presence of lead and cadmium by using the atomic absorption spectrophotometer (210VGP, Buck Scientific, Inc., Fort Point St., East Norwalk, CT., U.S.A.). The estimated levels of lead and cadmium for each sample were calculated as the mean of the metal levels in the two bottles expressed as μg/g on the basis of fresh weight sample.

3- Statistical Methods

Minimum, maximum, mean, standard deviation and standard error of mean as well as frequency distribution were used to describe data. These tests were analyzed using the Statistical Package for Social Scientists (SPSS) for windows 16.0 (SPSS Inc., Chicago, IL, and USA).

RESULTS

Table 1: Statistical analytical results of the estimated lead levels (μg/g wet weight) in the examined edible offal and muscle.

	Type of samples						
	kidney	Liver	Lung	Spleen	Lymph node (mesenteric)	Diaphragm (muscular part)	Brain
Valid No. of samples	30	30	30	30	30	30	30
Minimum	0.037	0.006	0.025	0.014	0.020	0.069	0.180
Maximum	5.804	4.642	5.768	5.970	5.769	5.004	4.457
Mean	1.674	0.919	2.206	2.681	2.818	1.641	1.201
SD	2.058	1.152	1.986	2.040	2.298	1.540	1.660
SE	0.376	0.210	0.363	0.372	0.420	0.281	0.303

SD =Standard Deviation SE= Standard Error of Mean

Table 2: Statistical analytical results of the estimated cadmium levels (μg/g wet weight) in the examined edible offal and muscle.

	Type of samples						
	kidney	Liver	Lung	Spleen	Lymph node (mesenteric)	Diaphragm (muscular part)	Brain
Valid No. of samples	30	30	30	30	30	30	30
Minimum	0.041	0.098	0.104	0.018	0.143	0.177	0.081
Maximum	1.133	1.138	1.135	1.324	1.141	1.155	0.851
Mean	0.611	0.564	0.773	0.657	0.645	0.779	0.488
SD	0.366	0.358	0.247	0.396	0.306	0.262	0.332
SE	0.067	0.654	0.045	0.072	0.056	0.048	0.061

SD =Standard Deviation SE= Standard Error of Mean

Table 3: Distribution of the investigated offal and muscle into classes with regard to the frequency of the lead concentrations (μg/g wet weight).

Samples	Concentration class (μg/g on wet weight basis)											
	<0.003	0.004-.01	0.02-0.1	0.2-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	Total	
											No.	%
Kidney	----	----	1	12	6	2	----	1	5	3	30	100
Liver	----	2	1	11	10	2	2	-----	2	----	30	100
Lung	----	----	2	4	9	2	2	2	5	4	30	100
Spleen	----	----	2	3	7	2	2	1	7	6	30	100
Lymph node (mesenteric)	----	----	4	7	1	1	1	2	6	8	30	100
Diaphragm (muscular part)	----	----	2	5	9	6	2	4	----	2	30	100
Brain	----	----	----	18	6	----	----	----	6	----	30	100

Table 4: Distribution of the investigated offal and muscle into classes with regard to the frequency of the cadmium concentrations (μg/g wet weight).

Samples	Concentration class (μg/g on wet weight basis)											
	<0.003	0.004-.01	0.02-0.1	0.2-1.0	1.1-1.5	1.6-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	Total	
											No.	%
Kidney	----	----	4	9	13	4	----	----	----	----	30	100
Liver	----	1	3	9	13	4	----	----	----	----	30	100
Lung	----	----	----	4	21	5	----	----	----	----	30	100
Spleen	----	----	----	10	14	6	----	----	----	----	30	100
Lymph node (mesenteric)	----	----	----	9	18	3	----	----	----	----	30	100
Diaphragm (muscular part)	----	----	----	5	19	6	----	----	----	----	30	100
Brain	----	----	----	6	6	18	----	----	----	----	30	100

Table 5: Agreement and non agreement number and percentage of the examined samples with E.O.S.Q.C. limits.

Samples	Lead								Cadmium							
	Mean	E.O.S.Q.C. level (μg/g wet tissue)	Number of sample						Mean	E.O.S.Q.C. level (μg/g wet tissue)	Number of sample					
			No. of agree		No. of not agree		Total no.				No. of agree		No. of not agree		Total no.	
			No.	%	No.	%	No.	%			No.	%	No.	%	No.	%
Kidney	1.674	Nil	00	00	30	100	30	100	0.611	≤ 2.00	26	86.67	4	13.33	30	100
Liver	0.919	Nil	00	00	30	100	30	100	0.564	≤ 2.00	26	86.67	4	13.33	30	100
Lung	2.206	Nil	00	00	30	100	30	100	0.773	≤ 2.00	25	83.33	5	16.67	30	100
Spleen	2.681	Nil	00	00	30	100	30	100	0.657	≤ 2.00	24	80.00	6	20.00	30	100
Lymph node (mesenteric)	2.818	Nil	00	00	30	100	30	100	0.645	≤ 2.00	27	90.00	3	10.00	30	100
Diaphragm (muscular part)	1.641	Nil	00	00	30	100	30	100	0.779	≤ 2.00	24	80.00	6	20.00	30	100
Brain	1.201	Nil	00	00	30	100	30	100	0.488	≤ 2.00	12	40.00	18	60.00	30	100
Total			00	00	210	100	210	100			164	78.10	46	21.90	210	100

DISCUSSION

Pollution of the environment with heavy metals is a serious problem due to the industrial growing and the improper hygienic practices leading to a build-up in the soil and environment where grazing animals may ingest them and hazardous effect occur even at a relatively low concentration (Royal Commission on Environmental Pollution, 1979).

The results represented in Table 1 revealed that the mean lead values in the bovine kidney, liver, lung, spleen, mesenteric lymph node, muscular portion of diaphragm and brain samples were 1.674, 0.919, 2.206, 2.681, 2.818, 1.641 and 1.201 μg/g wet weight respectively. The obtained results were lower than the results recorded by Mousa and Samaha (1993); Korénekova *et al.* (1998) while higher than those reported by Doganoc (1997); Kottferova and Korénekova (1997). The higher results may be attributed to that the animals may be held in industrialized areas or grazing upon near highways (Van Hassel *et al.*, 1980; Kreuzer and Rosopulo, 1981), high ability of lead to spread widely through environment (WHO, 1977; Monkiewicz *et al.*, 1986) and the increased level of lead in animal feed such as grass, hay, forage, silage and sludge (Van der Veen and Vreman, 1986; Salisbury *et al.*, 1991). Consequently lead has absorbed and accumulates in bones, liver and kidneys (Vos, *et al.*, 1987).

The given results in Table 2 revealed that the mean cadmium values in the bovine kidney, liver, lung, spleen, lymph node, diaphragm and brain samples were 0.611, 0.564, 0.773, 0.657, 0.645, 0.779 and 0.488 μg/g wet weight respectively. Our results were lower than the results recorded by Doganoc (1996); Korénekova *et al.* (1998), but higher than those reported by Jorhem *et al.* (1996); Kottferova and Korénekova (1997). The higher results may be attributed to the widespread industrial uses of cadmium and their highly ability to spread through environment (Venäläinen *et al.*, 1996; Doganoc 1999). Consequently cadmium inter the food chain via the use of the sewage sludge and the phosphate compounds as land's fertilizers results in an increased the cadmium level in the animal's feed, and animals tissues (Robards and Worsfold, 1991; Morcombe *et al.*, 1994).

Also from Table 1 & 2 high levels of lead and cadmium in the lung, lymph node and spleen may be attributed to that the main routes of contamination is through inhalation followed by ingestion. This is agree with the result recorded by Fkhry and Abd El-Fadil (1992) who pointed

that about 40-80% of the lead as a pollutant find its way to the body via the lungs, while about 10% was obtained from the contaminated food and water through the intestine. On the other hand the high levels of cadmium may be attributed to that the main sources of cadmium contamination were mining, fossil fuel, the coal combustion and consequently long range aerial transport and air born contamination (Sharma *et al.*, 1982; Ronneau and Cara, 1984).

The obtained results in Table 3, 4 and 5 showed that lead and cadmium were detected in 100% (210) of the examined samples. Although 25.71% (45) of the examined samples were ranged from 4.1 to 6 μg/g wet weight for lead, most of the examined samples were ranged from 0.2 to 1.5 μg/g wet weight for lead and cadmium with a percentage of 51.43% (108) and 74.29% (156) respectively. Regarding lead residues 210 (100%) of the samples was extremely exceeded the Egyptian permissible limits thus none of the samples were in agreement with the level established by E.O.S.Q.C., (1993). While 46 (21.904%) of the examined samples for cadmium could be considered unsuitable for human consumption according to E.O.S.Q.C., (1993). The majority of the samples levels of Cd were relatively approaching the maximum of the Egyptian permissible limits for Cd ($\leq$ 2 μg /g wet tissues). The higher ranges of lead and cadmium may be attributed to that the animals may be held in industrialized areas or grazing upon near highways (Kreuzer and Rosopulo, 1981). But the varied and wide range of each lead and cadmium concentration could be caused mainly by the difference between animal's exposure to the source of pollution, age, feed composition and individual differences (Kreuzer *et al.*, 1978; Vos *et al.*, 1987).

The discharge of heavy metals from industry are unlikely to be removed by leaching, due to the fact that heavy metals not broken down at all or may chelated over a long time scale to become permanent additions to the environment and animal consequently human tissues (Royal Commission on Environmental Pollution, 1979). Consequently heavy metals enter the human body via food, water, and air and by accumulation in the organisms endanger our health (Hecht, 1990).

Thus to ensure the safety of the consumer, it is recommended that farms should be far away from the highway, off dump sites or the industrial zone, introduction of quality assurance measures for all the components of the agriculture and animals industry, a sensitive and economic analytical technical program should be developed during the adoption of the ante-mortem and post-mortem inspection to monitoring

of metals in animal tissues, feed, air and water, allow a correct approach to the toxicological problems associated with the individual metal in the carcasses. Only edible offal of the animal less than two years is that one which could be consumed safely while offal and muscle tissues especially those of old animals bred in polluted zones, should be judged as unfit for human food and Strictly quality control procedures must be applied in meat production.

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