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DETERMINATION OF LEAD, CADMIUM AND COPPER RESDIUES IN MUSCLES, LIVER AND KIDNEYS OF SLAUGHTERED CATTLES AND SHEEP IN EL-SHARKIA GOVERNORATE.

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SUMMARY

Lead, cadmium and copper residues were determined in 20 cattles and 20 sheep which were slaughtered at Zagazig abattoir in El-Sharkia governorate. The weight of the examined slaughtered cattles ranged from 290 to 370 kg and their ages were less than 3 years, while the weight of the examied slaughtered sheep ranged from 38 to 50 kg and their ages were less than 4 years. The residues of these heavy metals were detected in muscle, liver and kidney of each animal by using Atomic Absorption Spectrophotometer. The obtained results revealed that the mean values + S.E. of lead residues in muscles, livers and kidneys of slaughtered cattles were 0.881 + 0.060, 1.102 + 0.064 and 1.284 + 0.081 p.p.m wet weight, respectively; and in slaughtered sheep were 0.735 + 0.120, 1.026 + 0.064 and 1.237 + 0.121 p.p.m wet weight, respectively; while the mean values + S.E. of cadmium residues in cattles were 0.309 + 0.029, 0.319 + 0.027 and 0.390 + 0.030 p.p.m wet weight, respectively; and in sheep were 1.066 + 0.015, 1.196 + 0.026 and 1.290 + 0.022 p.p.m wet weight, respectively. The mean values + S.E. of copper residues in cattles were 1.184 + 0.077, 19.007 + 0.404 and 2.161 + 0.060 p.p.m wet weight, respectively; and in sheep were 1.936 + 0.041, 37.193 + 1.078 and 3.549 + 0.202 p.p.m wet weight, respectively. The present results were evaluated according to the permissible limits of WHO (1972), FAO/WHO (1972) and Egyptian Organization for Standardization and Quality Control. "E.O.S.Q.C." (1993). It could be concluded that lead, cadmium and copper residues in slaughtered cattles and sheep were within the permissible limits except cadmium residues in slaughtered sheep were higher than the permissible limits of FAO/WHO (1972) and E.O.S.Q.C. (1993), also copper residues in sheep liver were higher than the permissible limits, recommended by Casarett and Doull (1975). The public health importance and sources of meat contamination by heavy metals were discussed.

INTRODUCTION

The contamination with heavy metals such as lead, cadmium and copper which are widely distributed in the air, agricultural lands and water is possible, these metals are taken in by plants and animals and make their way into the food chain. Several elements are known to be essential at low concentrations but at high levels they are toxic.

In recent years, much attention had been paid to the possible danger of metal poisoning in human as a result of consumption of contaminated meat. It has also been reported that toxic heavy metals (lead and cadmium) are concentrated mostly in kidneys and livers of animals (Carlton and Henderson, 1977). The risk of exposure of human to heavy metals contained in edible organs of animals has received widespread concern (Falandysz, 1991).

Lead: (Pb) is a toxic metal which accumulates in the body due to its low rate of elimination. Chronic lead poisoning is characterized particularly by liver dysfunction, anemia, muscular pain, lead nephropathy and neuropathy of both central and peripheral nervous system (Goldfrank et al., 1990), its potential carcinogenic nature has also been shown by Zawurska and Medras (1988) its biological half-life in bone is about 27 years (Shibamoto and Bjeldanes, 1993).

Cadmium: (Cd) is also a toxic element for human being, it is virtually absent from the human body at birth, it is accumulated with age in body tissues and cause renal failure (Gracey and Collins, 1992). There are two sources of human food contamination with cadmium; direct sources from which cadmium is transferred into the food without passing through intermediate links and indirect sources from which is passing through environmental links i.e. air, water phases or soil (Engberg and Bro-Rasmussen, 1974). Cadmium had a significant role in the incidence of some diseases as diabetes mellitus (Merali and Singhal, 1977), chronic renal failure (Friberg, 1984), human hypertension (Nishiyama et al., 1986) and anemia in all species (Watanabe and Murayame, 1974). Air pollution with cadmium from industrial sources (manufacturing of plastics, solder alloys, nickle-cadmium batteries, photocells and rubber tires) may be transmitted to man through contaminated vegetables used as food stuffs or through food of animal origin (Carstensen and Poulsen, 1974).

Copper: (Cu) occurs in foods in many chemical forms and combinations which affect availability to the animal and tends to be accumulated in the liver and kidneys.

The aim of this study was to determine the residues of lead, cadmium and copper in muscles, livers and kidneys of some slaughtered cattles and sheep at Zagazig abattoir in El-Sharkia governorate to ensure their safety for human consumption.

MATERIALS AND METHODS

Collection of samples:

A total of 120 samples were collected from 20 cattles and 20 sheep directly after slaughtering and evisceration at Zagazig abattoir in El-Sharkia governorate. Three samples were collected from each animal (muscle "longissimus" dorssii, liver and kidney), the weight of each examined sample ranged from 50 to 100 gm and were stored frozen at -20°C until analysis was carried out.

Digestion and analysis of samples:

The collected samples were examined for measuring the levels of lead, cadmium and copper. The samples were prepared and digested according to the technique described by Khan et al. (1995) and were analysed by using the Atomic Absorption Spectrophotometer (UNICAM 969 AA Spectrometer) under the following conditions:

Metal / Condition	Lead (Pb)	Cadmium (Cd)	Copper (Cu)
Methods	Normal segmented curve fit	Normal segmented curve fit	Normal segmented curve fit
Measurement time	4.0 Second	4.0 Second	4.0 Second
Wave length (nm)	217	228.8	324.8
Lamb current/m.am	15	8	5
Technique	Flame	Flame	Flame
Flame Type	Air/Acetylene	Air/Acetylene	Air/Acetylene
Air/1	30	30	30
Acetylene/1	20	20	20
Fuel flow (L/Min)	1.1	1.2	1.1

N.B.: The estimation of such heavy metals in each examined sample was in p.p.m on the basis of wet weight sample.

RESULTS

The concentrations of lead, cadmium and copper in muscles, livers and kidneys of slaughtered cattles and sheep were statistically analysed and summarized in table (1) and (2).

Table (1): Concentrations of lead, cadmium and copper (p.p.m) wet weight in muscles, livers and kidneys of slaughtered cattles.

Metal	No. of examined samples	Type of examined samples	Min.	Max.	$\bar{X}$	S.D.	S.E.	C.V.
Lead (Pb)	20	Muscles	0.555	1.303	0.881	0.268	0.060	30.419
	20	Livers	0.700	1.560	1.102	0.286	0.064	25.953
	20	Kidneys	0.780	1.792	1.284	0.366	0.081	28.505
Cadmium (Cd)	20	Muscles	0.155	0.492	0.309	0.132	0.029	42.718
	20	Livers	0.165	0.497	0.319	0.124	0.027	38.871
	20	Kidneys	0.230	0.569	0.390	0.130	0.030	33.333
Copper (Cu)	20	Muscles	0.650	1.600	1.184	0.343	0.077	28.970
	20	Livers	16.200	21.246	19.007	1.808	0.404	9.512
	20	Kidneys	1.625	2.500	2.161	0.269	0.060	12.498

Min: Minimum value, Max: Maximum value, $\bar{X}$: Mean values.

S.D.: Standard Deviation, S.E.: Standard Error.

C.V.: Coefficient of variation. $C.V. = \frac{S.D.}{\bar{X}} \times 100$

p.p.m : Part per million

Table (2): Concentrations of lead, cadmium and copper (p.p.m) wet weight in muscles, livers and kidneys of slaughtered sheep.

Metal	No. of examined samples	Type of examined samples	Min.	Max.	$\bar{X}$	S.D.	S.E.	C.V.
Lead (Pb)	20	Muscles	0.033	1.520	0.735	0.537	0.120	73.061
	20	Livers	0.570	1.350	1.026	0.287	0.064	27.973
	20	Kidneys	0.442	1.925	1.237	0.539	0.121	43.573
Cadmium (Cd)	20	Muscles	0.955	1.220	1.066	0.071	0.015	6.660
	20	Livers	1.061	1.385	1.196	0.115	0.026	9.615
	20	Kidneys	1.140	1.400	1.290	0.096	0.022	7.442
Copper (Cu)	20	Muscles	1.700	2.220	1.936	0.185	0.041	9.556
	20	Livers	19.000	51.714	37.193	4.822	1.078	12.964
	20	Kidneys	2.769	5.066	3.549	0.905	0.202	25.500

DISCUSSION

Heavy metals make up one of the most important groups of pollutants, so it is necessary to monitor the level of heavy metal contaminants which may be avoidably present in meat and its products.

Lead: (Pb) concentrations in muscles, livers and kidneys of slaughtered cattles outlined in table (1) ranged from 0.555 to 1.303, 0.700 to 1.560 and 0.780 to 1.792 with mean values + S.E. of 0.881 + 0.060, 1.102 + 0.064 and 1.284 + 0.081 p.p.m wet weight, respectively; while lead concentrations in slaughtered sheep (Table 2) ranged from 0.033 to 1.520, 0.570 to 1.350 and 0.442 to 1.925 with mean values + S.E. of 0.735 + 0.120, 1.026 + 0.064 and 1.237 + 0.121 p.p.m wet weight, respectively.

The mean values of lead concentrations in slaughtered cattles and sheep in table (1) and (2) when converted form p.p.m (mg/kg) to (mg/100 gm) as the human daily intake from meat is 100 gm, the obtained findings were within the permissible limits which reported by WHO (1972) who gave a provisional tolerable weekly intake of lead by man as 3 mg/person or 0.05 mg/kg body weight, Casarett and Doull (1975) reported that the human daily intake of lead is 0.3 mg and Egyptian Organization for Standardization and Quality Control "E.O.S.Q.C." (1993) who mentioned that the maximum provisional weekly intake from lead by human is 0.05 mg/kg body weight. The recorded results of lead in table (1) agreed with those reported by Salisbury et al. (1991) except in cattle kidneys (2.970 mg/kg) which were higher than the obtained results. Nearly similar findings in imported frozen meat were recorded by Youssef (1994). Low lead levels in cattle were detected by Sharma et al. (1982) , Aranha et al. (1994) , Tsoumbaris and Tsoukali-Papadopoulou (1994) and Doganoc (1996). On the other side high lead findings in cattles were recorded by Grahwit (1972) and Boulis (1993) .

The recorded results outlined in table (2) nearly agreed with the findings reported by Salisbury et al. (1991) but lead concentrations in liver of sheep and lamb (0.040 to 0.300 mg/kg) were lower than the recorded results in table (2), also lower lead levels in slaughtered sheep were estimated by Amodio-Cocchieri and Fiore (1987), Falandysz (1991) and Schulz-Schroeder (1991).

Low lead levels in the present data might be due to the collection of slaughtered animals (cattles and sheep) from areas subjected to low environmental pollution with lead. However the animals were exposed to the element for short time in these areas. This held the view reported by Doganoc (1996) and Schulz-Schroeder (1991) on the other hand, the presence of the high levels of lead in few samples in examined cattle carcasses may be attributed to the accumplative effect of such metal in tissues. This concide the finding reported by Boulis (1993).

Cadmium (Cd): The results illustrated in table (1) pointed out that the concentrations of cadmium in muslces, livers and kidneys of slaughtered cattles ranged from 0.155 to 0.492, 0.165 to 0.497 and 0.230 to 0.569 with mean values + S.E. of 0.309 + 0.029, 0.319 + 0.027 and 0.390 + 0.030 p.p.m wet weight, respectively; while in slaughtered sheep (Table 2), the cadmium values ranged from 0.955 to 1.220, 1.061 to 1.385 and 1.140 to 1.400 with mean values + S.E of 1.066 + 0.015, 1.196 + 0.026 and 1.290 + 0.022 p.p.m wet weight, respectively.

The recorded results of cadmium in slaughtered cattles and sheep in table (1) and (2) were within the limits which reported by Anon (1963) who recorded that the highest permissible level for cadmium in food is 13 p.p.m, and when the mean values of cadmium concentrations in slaughtered cattles and sheep converted from p.p.m. (mg/kg) to (mg/100 gm) as the human daily intake from meat is 100 gm, the obtained findings were within the permissible limit which intended by Casarett and Doull (1975) who mentioned that the human daily intake of cadmium is 0.018 - 0.20 mg and the obtained results of cadmium in cattle (mg/100 gm) were within the permissible limits intended by FAO/WHO (1972) who mentioned that the mean content of cadmium in food should not exceed 0.04 - 0.05 mg/kg and Egyptian Organization for Standardization and Quality Control "E.O.S.Q.C." (1993) who gave a maximum provisional weekly intake from cadmium by human as 0.0067 - 0.0083 mg/kg body wieght, also nearly similar findings in cattles were recorded by Amodio-Cocchieri and Fiore (1987), Boulis (1993) and Doganoc (1996). Low findings of cadmium in cattles were reported by Protasowicki (1992) and Aranha et al. (1994) but high cadmium values in cattles were detected by Sharma et al. (1982), Youssef et al. (1988) and Zmudzki and Szkoda (1995).

The investigated results of cadmium concentrations in slaughtered sheep (Table 2) nearly agreed with those reported by Amodio-Cocchieri and Fiore (1987), but low figures of cadmium in sheep were recorded by Falandysz (1991) and Schulz- Schroeder (1991). The present results of cadmium in sheep in table (2) were higher than the permissible limits which recommended by FAO/WHO (1972) and Egyptian Organization for Standardization and Quality Control "E.O.S.Q.C." (1993).

The high values of cadmium in examined sheep samples (muscles, livers and kidneys) may be attributed to the grazing of sheep in polluted pasture with cadmium from industrial sources which may be increased the level of the element in surrounding environment. The actual extent of absorption depends on a number of dietary factors such as the intake of protein, calcium, vitamin D and other trace metals. Following absorption, cadmium is transported and bound to certain proteins of the plasma and red blood cells to other sites throughout the body. The cadmium is toxic to virtually every system in the body, whether ingested, injected or inhaled. However, the metabolism of the cadmium was antagonized with the copper and iron leading to anemia. This agrees with that reported by Underwood (1977)

Copper (Cu): The copper concentrations in muscles, livers and kidneys of slaughtered cattles ranged from 0.650 + 1.600, 16.200 to 21.246 and 1.625 to 2.500 with mean values + S.E. of 1.184 + 0.077, 19.007 + 0.404 and 2.161 + 0.060 p.p.m wet weight, respectively (Table 1); while copper concentrations in slaughtered sheep in table (2) ranged from 1.700 to 2.220, 19.000 to 51.714 and 2.769 to 5.066 with mean values + S.E. of 1.936 + 0.041, 37.193 + 1.078 and 3.549 + 0.202 p.p.m wet weight, respectively.

The mean values of copper concentrations in slaughtered cattles and sheep in table (1) and (2) when converted from p.p.m (mg/kg) to (mg/100 gm) as the human daily intake from meat is 100 gm, the obtained findings were within the permissible limits which recommended by Casarett and Doull (1975) who reported that the "human daily intake of copper is 3.2 mg" except copper values in sheep livers were little higher than the permissible limits and the obtained results also were within the permissible limits which itended by Egyptian Organization for Standardization and Quality Control (1993) who mentioned that the maximum human daily intake of copper is 0.05 - 0.5 mg/kg, body weight, also the obtained findings of copper in table (1) were nearly similar to those reported by Doornebal and Murray (1981), Marchello et al. (1984), Poul and Southgate (1978) and Medeiros et al. (1988). Low findings of copper in imported frozen meat samples were estimated by Youssef (1994), but high copper values in cattles were detected by Frqslie et al. (1980), El-Sherif (1991) and Steinhardt et al. (1993).

The obtained results of copper in sheep (Table 2) were lower than the results recorded by Bjorkman and Luthman (1980), Solly et al. (1981) and Meyer and Coenen (1994).

The high values of copper in examined sheep liver may be attributed to the collection of such animals from areas subjected to heavy environmental pollution with such element. This may be reflected on concentration of copper in feed intake, soil and water. However chronic copper poisoning may occur in animals under natural grazing conditions. Moreover, the liver is greatly susceptible to metabolic changes and retention after copper absorption. This concides with that reported by Narres et al. (1984) and Diab (1995).

Finally it could be concluded that the obtained results of lead in slaughtered cattles and sheep were within the permissible limits of WHO (1972), Casarett and Doull (1975) and E.O.S.Q.C.(1993). Cadmium concentrations in slaughtered cattles and sheep were in acceptance to the recommended levels intended by Casarett and Doull (1975), also cadmium levels in slaughtered cattles were within the permissible limits of FAO/WHO (1972) and E.O.S.Q.C. (1993) but in case of slaughtered sheep, the cadmium levels were higher than these recommended limits. The copper concentrations in cattles and sheep were within the permissible levels recommended by Casarett and Doull (1975) except copper values in sheep livers were higher than this permissible limits, while the copper values in slaughtered cattles and sheep were within this permissible limit of E.O.S.Q.C.(1993).

N.B. (1) The comparing of the recorded results in table 1 and 2 with the standard permissible limits were based on the conversion of the obtained results from mg/kg (p.p.m) wet weight in tissues (muscles, liver and kidneys) of slaughtered cattles and sheep to mg/100 gm daily fresh consumable meat by human (70 kg body weight).

(2) The residue limit of lead, cadmium and copper in raw meat, liver and kidneys of slaughtered animals were not included in the E.O.S.Q.C. (1993).

(3) mg/kg = µg/g = p.p.m.

(4) FAO: Food and Agriculture Organization.

(5) WHO: World Health Organization.

The hazardous toxic elements, are investigated in this study included lead, cadmium and copper. The animals subjected to these hazardous elements differ from country to another according to the excreted from the industrial, insecticidial and dietetic regimens as well as the persistance of this pollutant in the environment.

Therefore the preventive measures intended for minimizing the pollution of raw meat with such metals are of significant concern, including:

1- Minimizing the use of phosphates and sludge for land fertilization as possible.

2- periodical examination should be done for meat and other meat products as well as the edible organs and their load for heavy metals should be evaluated according to the international guide lines as a fruitful advise to delay environmental contamination.

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