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TRACE METAL LEVELS IN SOME SELECTED FOOD ITEMS

(With 2 Tables)

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تقدير مستوى العناصر النادره فى بعض المنتجات الغذائيه

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يعتبر تقدير العناصر النادره فى غذاء الأنسان ذات الاصل الحيوانى من الأهميه الصحيه حيث أن زيادتها عن معدلاتها الطبيعيه تؤثر على صحة الانسان. تم تعيين مستوى عنصر الكادميوم، النحاس، الرصاص، النيكل والاسترانشيوم فى كل من عينات لبن البودره والبلوبيف وأوضحت النتائج أن متوسطات هذه العناصر كانت ٠٣٩٤ ر٠٠ ، ٠٦٨٠ ر٠ ، ٧٣٠٠ ر٠ ، ٠٥٤٢ ر٠ ، ٠٩٣٨ ر٠ (ميكروجرام/جرام) فى عينات لبن البودره بينما كانت المتوسطات ٠٧٠٤ ر٠ ، ٠٧٤٣ ر٠ ، ٨٢٦٠ ر٠ ، ٠٧١١ ر٠ و ٠٤٨٦ ر٠ (ميكروجرام/ جرام) لعينات معلبات البلوبيف على التوالى. وقد لوحظ أن متوسطات هذه العناصر محل الدراسه كانت فى الحدود المقبوله أو المسموح بها دوليا فى مثل هذه الأنواع من الأغذيه كما تم مناقشة مصادر التلوث المختلفه بمثل هذه العناصر وكذلك تمت مناقشه الأهميه الصحيه لكل عنصر على حده وتأثير زيادتها على صحة الأنسان. كذلك تم مناقشة الطرق المختلفه للوقايه من زيادة أو نقص مثل هذه العناصر النادره فى كل من الانسان والحيوان.

SUMMARY

Heavy metals have been determined in some selected food items of animal origin. The levels of cadmium, copper, lead, nickel and strontium have been measured in milk powder and corned beef samples. The mean values of such investigated elements were 0.0394, 0.0680, 0.7300, 0.0542 and 0.0938 ug/g in examined milk powder samples, whereas, they were 0.0704, 0.0743, 0.8260, 0.0711 and 0.0486 ug/g in examined corned beef samples, respectively. Puplic health importance and sources of food contamination by trace elements were discussed.

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***Keywords:** Trace metal levels in some selected food items*

INTRODUCTION

Although toxic metals are naturally present in the environment, industrial processes have resulted in an increased concentration of heavy metals in air, water and soil. Subsequently, 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 higher levels they are toxic. This is complicated even further if 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)*.

Cadmium is virtually absent from the human body at birth and it is accumulated with age in body tissues and cause kidney 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 intermediate links and indirect sources, from which cadmium is passing through environmental links, i.e. air, water phases or soil *(ENGBERG and BRO-RASMUSSEN, 1974)*. Cadmium is toxic to virtually every system in the animal body, whether ingested, injected or inhaled. Anemia is a common manifestation of chronic cadmium toxicity in all species, due at least in part to its metabolic antagonism to copper and iron. Milk and meat are poor sources of cadmium, except for kidney *(UNDERWOOD, 1977)*. The mean levels of cadmium (ppm) in the muscle of examined cattle were 0.082 *(MUSSMAN, 1975)*; 0.002 (Holm, 1976); 0.050 *(RUTTNER and JARC, 1979)*; 0.250 *SOLLY et al., 1981)*;0.002 *(HECHT, 1983)* and 0.020 *(PROTASOWICKI, 1992)*.

Copper occurs in foods in many chemical forms and combinations which affect its availability to the animal. Several inorganic dietary factors markedly affect copper absorption, retention and distribution within the body. The extent of copper absorption is also influenced by the age of the animal. The copper content of milk varies with the species, stage of lactation, and copper nutriture of the animal. Subnormal copper levels in the milk of ewes and cows grazing copper deficient pastures, with values as low as 0.01-0.02 ug/ml, have been reported by *BECK (1941)*. Adding copper to diets already adequate in this element has little effect on the copper content of the milk of cows, goats *(ELVEHJEM et al., 1929)*, and women *(MUNCH-PETERSEN, 1951)*.

The dairy products, white sugar and honey are considered the poorest sources of copper, which rarely contain more than 0.5 ppm *(UNDERWOOD, 1977)*. The mean copper levels in longissimus dorsi, semimembranosus and diaphragm muscles of cattle were 0.70, 0.82 and 1.66 ppm wet weight, respectively *(DOORNENBAL and MURRAY, 1981)*, whereas, they were 2.8 for cattle, 2.9 for sheep and 2.6 ppm wet weight for pig samples *(SOLLY et al., 1981)*. However, *MEDEIROS et al. (1988)* stated that mean for copper contents of raw longissimus and semimembranosus muscles of beef were 1.08 and 1.07 ppm wet weight, respectively, while *PROTASOWICKI (1992)* reported that the mean copper content in beef was 0.56 ug/g. Abnormally high liver copper levels are characteristic of a number of diseases in man. These include Mediteranean anemia, hemochromatosis, cirrhosis and yellow atrophy of the liver, severe chronic diseases accompanied by anemia and Wilson's disease (hepatolenticular degeneration) *(UNDERWOOD, 1977)*.

Lead is recognized as a toxic substance which accumulates in the body due its low rate of elimination. Chronic lead poisoning is characterized particularly by neurological defects, renal tubular dysfunction and anemia. Damage to the central nervous system is a marked and common feature, especially in children with their low lead tolerance *(Underwood, 1977)*. Its potential carcinogenic nature has also been shown by *ZAWURSKA and MEDRAS (1988)*, and its possible effects on neurological and psychomotor functions has been stated by *PUESCHEL (1974) and SILBERGELD et al. (1975)*. On the other hand, *KIRKPATRICK and COFFIN (1974)* noticed that the levels of lead in samples of canned food products were below the legal limits in Canadian diets which verying from 5-10 ppm. Also they reported that levels of lead were increased with storage time, as a result of solder used in can manufacture, where the solder is composed of 98% lead and 2% tin. However, the median values of lead in the meat of cattle were 0.02 ppm fresh matter in West Germany *(HOLM, 1976)*, 0.31 ppm in Upper Austria *(RUTTNER and JARC (1979)*, and 0.08 mg/kg wet weight in the Northern region of Poland *(FLANDYSZ and LORENCE-BIALA, 1991)*.

Nickel occurs in low concentrations in all animal tissues and fluids and distributed throughout the body without particular concentration in any known tissue or organ and does not accumulate with age in any human organ other than the lungs *(TIPTON and COOK, 1963)*. Nickel deficient has adverse effect on iron storage in the liver, spleen and kidneys *(SCHNEGG and KIRCHGESSNER (1976)*. Nickel level is very low foods of animal origin as muscles, meat meals, fish meals, milk and other dairy products *(SCHROEDER et al., 1961 and ZOOK et al., 1970)*. The mean nickel level in examined imported frozen meat samples was 0.1269 ug/g dry weight *(YOUSSEF, 1994)*.

Although there is no conclusive evidence that strontium is essential for living organisms, a wide margin of safety exists between dietary levels of stable strontium likely to be ingested from ordinary foods and water supplies and those that induce toxic effects *(UNDERWOOD, 1977)*. The movement of calcium and strontium about the body depends on their relative rates of transmission across biological membranes, where Sr/Ca ratio is higher in the faeces than in the food which suggests that calcium is absorbed preferentially by the intestine. The renal clearance of calcium is three to five times higher than that of strontium, presumably because of preferential reabsorption of calcium by the tubules *(WIDDOWSON, 1992)*. The importance of dietary calcium to the toxicity of strontium is evident from studies reported by *WEBER et al. (1968)* as reduction in growth rate, in addition to an impairment of the calcification of bones and teeth, and a higher incidence of carious teeth *(Rygh, 1949)*. *GERLACH and MULLER (1934)* reported that the strontium concentration in animal tissues ranged from 0.01 to 0.10 ppm, with no evidence of accumulation in any particular species, soft organ or tissue. However, *WIDDOWSON et. al, (1960)* stated that the dried cow's milk formula, diluted with tap water as fed to the infants, contained 52.5 ug stable strontium per 100 ml compared with 6.9 ug per 100 ml for breast milk. The daily strontium intakes from the food of adults in seven regions of India ranged from 3.1 to 4.7 mg/day *(SOMAN et al., 1969)*, whereas the kidneys control the amount of strontium in the body as they do of calcium. Young breast-fed infants did not retain strontium but formula-fed infants, with much higher intakes, retained 70%.*YOUSSEF (1994)* found that the mean value of strontium in imported frozen meat was 0.0098 ug/g dry weight sample.

In Egypt, *YOUSSEF et al. (1988)* stated that the mean cadmium and copper levels in examined diaphragm muscle of cattle were 1.15 and 11.64 ug/g dry weight, respectively, whereas *BOULIS (1993)* reported that the mean values of cadmium, copper and lead in examined muscles of cattle were 0.382, 8.918 and 4.388 ug/g on the basis of wet weight sample, respectively . Also, the mean cadmium, copper, lead, nickel and strontium levels were 0.0739, 0.6723, 0.8030, 0.1269 and 0.0098 ug/g dry weight as determined by *YOUSSEF (1994)*.

Chemical determination of the trace element levels in human and animal diets and their components provide the best indication of levels of intake in relation to minimum needs and toxic potential. Reasonbly satisfactory standards of adequacy and safety assessed against such criteria as growth, health, performance and tissue concentrations have been developed for most of the trace elements. Therefore the object of the present study is to deterninate the levels of cadmium, copper, lead, nickel and strontium in some selected food items such as milk powder and corned beef samples.

MATERIAL and METHODS

A total of 61 varieties of some selected food items including 41 milk powder and 20 corned beef samples were collected from different supermarkets and pharmacies in Assiut city to determine the levels of some trace metals. The collected samples were prepared and digested according to the technique recommended by *Fahmy (1971) and Gajan and Larry (1972)*, where one gram of each sample, 5 ml of 50% sulphuric acid and 5 ml concentrated nitric acid were added in clean dry flask.

The flasks were heated gently until clear fumes of nitric and sulphuric acids appear, where the flame was turend off and the flasks allowed to cool . Complete digestion is indicated by colourlessness of the liquid.

The digested samples were diluted by Hcl N/10 and bidistilled water then filterated.

The previously digested and filterated samples were prepared for measurement the levels of cadmium, copper, lead, nickel and strontium in each sample by using the Atomic Absorption Spectrophotometer Perkin Elmer 2380. The operational conditions for Atomic Absorption were as follow; acetylene 2.4 ml^{-1}; air, 6.3, ml min^{-1}; lamp current, 1.0 nm. The estimation of such trace elements under investigation in each examined sample was in ug/g on the basis of wet weight sample.

RESULTS

The obtained results were outlined in Tables (1) and (2).

DISCUSSION

The contamination of food has a critical impact on its health properties. It causes either instant morbid changes or changes in proper functioning of organism noticeable only after some time. Sometimes the effect are visible no sooner than in the next generations. Heavy metals make up one of the most important groups of pollutants. So, it is necessary to monitor the level of heavy metals contaminants which may be avoidably present in otherwise nutritious and healthy foods.

The mean cadmium, copper, lead, nickel and strontium levels outlined in Tables (1) and (2) were 0.0704, 0.0743, 0.8260, 0.0711 and 0.0486 ug/g in examined milk powder samples, while they were 0.0394, 0.0680, 0.7300, 0.0542 and 0.0938 ug/g in examined corned beef samples, respectively.

Concerning the cadmium levels, the obtained results appeared to be within permissible limits reported by *ANON (1963)* who recorded that 13 ppm of cadmium is the highest permissible level for food. Also, the present levels were in acceptance to FAO/WHO (1972) who mentioned that the mean content of cadmium in food should not exceed 0.04 - 0.05 mg/kg. On the other hand, there are currently no UK limits for cadmium in food. However, the recommendation of UK Food Advisory Committee is that food containing levels of cadmium not acceptable in its country of origin should not be admitted to the UK. In general, though the concentrations of cadmium in food in the UK are low, some foods of minor dietary inportance such as shellfish or kidney often contain levels in excess of 0.5 mg/kg *(WATSON, 1993)*

Copper is an essential element for all plants and animals. It is widely distributed and always present in food. Animals livers, which are the major contributor to dietary exposure to copper, various shellfish and some dry materials contain, on average, more than 20mg/kg. This was the limit recommended for food by the Food Standards Commitee in 1956. Milk contains little copper, usually less than 0.1 mg/kg *(HARRISON, 1993)*.

Lead exists in small quatities in the eath's crust, but is well known as it is extracted easily from its ores. It is a grey, ductile, malleable metal which has used extensively by man from earliest times, with references to it being found in Egyptian hieroglyphics of around 1500 BC. The intake of lead in food by the general population in the UK is well within international tolerable limits. Although dietary lead intakes in the UK are well within recommended intakes, it is the Government's policy to ensure that exposure to lead is reduced wherever practicable. So, changes in canning technology by Uk industry have resulted in the replacement of lead-soldered cans by using welded side-seams and this in turn has led to a fall in lead levels of UK-produced canned foods *(WATSON, 1993)*. The mean lead values of either examined milk powder and corned beef samples under investigation were below the legal limits mentioned by *KIRKPATRICK and COFFIN (1974)* who found that the levels of lead in samples of canned food products were less than the legal limits which varying from 5-10 ppm.

Nickel occurs in low concentration in all animal tissues and fluids, and it does not accumulate with age in any human organ other than the lungs *(UNDERWOOD, 1977)*. Salts of this metal are widely used in industry for nickel planting and as pigments. Nickel is very low in foods of animal origin as muscles meats, milk and other dairy products and fish meals *(SCHROEDER et al., 1961 and ZOOK et al., 1970)*. Nickel is a relatively non-toxic element, so that nickel contamination of foods does not present a serious health hazard. Acid foods take up nickel from nickel vessels during cooking, but it is poorly absorbed and causes no detectable damage *(PHATAK and PATWARDHAN, 1950)*. More than half the amount of nickel in the food was absorbed and excreted in the urine *(WIDDOWSON, 1992)*.

The metabolic behaviour of strontium, and particulrly its interaction with calcium, have attracted considerable attention. There is no conclusive evidence that stronium is essential for living organisms *(UNDERWOOD, 1977)*. Although, *RYGH (1949)* reported that the omission of this element from the mineral supplement fed to rats and guinea pigs consuming a purified diet resulted in growth depression, on impairment of the calcification of bones and teeth, and a higher incidence of carious teeth. The movement of calcium and strontium about the body depends on their relative rates of transmission across biological membranes. However, *WIDDOWSON, (1992)* reported that some strontium is absorbed and retained in the body and some is secreted in milk.

Concerning the heavy metals levels in canned food, *ANTHONY LOPEZ and WILLIAMS (1985)* pointed out that copper and manganese elements were decreased significantly in canned food due to processing. In most instances this decrease was due to the element being leached into the brine. On the other hand, nickel was increased significantly, due to the addition of brine. Finally, it is concluded that the levels of cadmium, copper, lead, nickel and strontium were within acceptable limits or within normal levels recommended by some investigators.

The importance of trace elements has been recognized in the maintenance of optimum nutrition and health, as well as, in the beneficial effects of more complete information for use in nutritional labeling *(ROCKLAND et al., 1979)*.

Table 1: Statistical analytical results of some trace elements (ug/g wet weight) in examined milk powder samples.

Element	No. of examined samples	Minimum	Maximum	Mean	Standard Deviation
Cadmium	41	0.0130	0.5850	0.0704	0.1208
Copper	41	0.0200	0.1310	0.0743	0.0248
Lead	41	0.1800	1.6100	0.8260	0.4645
Nickel	41	0.0100	0.1100	0.0711	0.0260
Strontium	41	0.0001	0.1180	0.0486	0.0330

Table 2: Statistical analytical results of some trace elements (ug/g wet weight) in examined corned beef samples.

Element	No. of examined samples	Minimum	Maximum	Mean	Standard deviation
Cadmium	20	0.0110	0.0820	0.0394	0.0146
Copper	20	0.0120	0.1540	0.0680	0.0329
Lead	20	0.1300	1.1700	0.7300	0.1775
Nickel	20	0.0010	0.1300	0.0542	0.0324
Strontium	20	0.0001	0.2620	0.0938	0.0671

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