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Effects of Heavy Metals Residues On Human Health

Firdevs MOR[1] Özen KURŞUN[2] Neslihan ERDOĞAN[3]

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Abstract: Pollution of the environment is one of the most dangerous problems, we faced, which is also treating the human and animal health and causes natural imbalance. Rapid increases in pollution, development of industry, fuel wastes of recycling, mine wastes, extensive agricultural pesticide use, phosphate fertilizers, irrigation of agricultural land with contaminated water may cause rapid dirtiness of environments. Therefore, soil and water resources are become polluted and directly effect on human, plants and animals. Food sources get polluted by these agents as well. Heavy metals are resistant to environmental conditions and they have a tendency to accumulate on plants, animal and human tissues. Particularly in last decade, metal toxicities are gained importance, because they may even result in death of human and animal.

Key Words: Heavy metal, residue, health.

Ağır Metal Kalıntılarının İnsan Sağlığı Üzerine Etkileri

Özet: Çağımızda doğal denge ile insan ve hayvan sağlığını tehdit eden tehlikelerin başında çevre sorunlarının geldiği kabul edilmektedir. Ülkemizde hızla artan nüfusun ve sanayinin gelişimine bağlı olarak ciddi boyutlarda çevre kirliliği şekillenmektedir. Günümüzde hızlı endüstriyel gelişme, kullanılan yakıtlar, atıkların geri dönüşümlü olarak kullanılması, maden ocakları, yoğun tarımsal ilaç ve fosfatlı gübreler, atık sularla tarım alanlarının sulanması metaller ve metalik bileşiklerin çevreye yayımında etkili olmaktadır. Bu nedenle toprak, su kaynakları ile bitki örtüsü kirlenmekte, insan ve hayvanların tükettiği gıdalarda bu kirleticilerden etkilenmektedir. Ağır metaller çevre şartlarına dayanıklı olup biyolojik sistemlerde ve besinlerde birikim yaparlar. Son yıllarda önem kazanan metal toksikasyon olgularında metalin türü, diğer metallerle etkileşimi ve konsantrasyonlarına bağlı olarak insan ve hayvanlarda ölüme kadar gidebilen zehirlenmelere yol açar.

Anahtar Kelimeler: Ağır metal, kalıntı, sağlık.

[1] Faculty of Veterinary Medicine, Department of Pharmacology and Toxicology, The University of Mehmet Akif Ersoy, 15100, Burdur, Turkey.

[2] Faculty of Veterinary Medicine, Department of Food and Technology, The University of Mehmet Akif Ersoy, 15100, Burdur, Turkey.

[3] Faculty of Arts and Sciences, Department of Biology The University of Mehmet Akif Ersoy, 15100, Burdur, Turkey.

Introduction

The heavy metals, such as lead, cadmium, arsenic and mercury are also found as pollutant substance within the human body, although the heavy metals, such as zinc, iron cobalt and selenium are necessary elements for normal development and growing humans and animals[6,13]. When living creatures, excessively exposed these metals, they become harmful. It is mentioned that heavy metals are encountered among unknown reasons of disasters lasting for a long time[37]. Therefore, protection purposed studies, which are performed for less influence of toxic effects of heavy metals mainly against humans and also the other living creatures, are increasing more and more. A lot of researches, which directed towards determining their presence level within tissues and organs of cattle for the sake of preventing the metals such as, especially, aluminum, arsenic, cadmium, lead and mercury, are being carried out at most of the countries[34,38]. If it is exposed to these metals by means of water and foods in small amounts continuously, then those humans and animals face with rickets, form disorders, and functional disorders of various organs mainly in livers, kidneys and spleens; if it is exposed with excessive amounts, it causes to the cases of being poisoned, which leads to death events[25]. Average concentrations of the heavy metals, which have been determined in some food substances, are shown in Table-I[31].

Investigations directed to toxic effects and quantity levels of heavy metals found out that these substances have strong teratojenik effects on embryos of many tested animals[22]. Excessive intake of mercury, lead, cadmium, arsenic, aluminum, copper, zinc, iron, selenium and chromium may show immune-toxic effects, besides their usual toxic effects[27,40]. However, metals such as iron enter into hemoglobin structure and perform their functions over there, while biological trace elements, such as zinc, copper, selenium and iron constitutes the structure of subsidiary co-factors of cellular enzymes[39,46].

As an indicator of environmental pollution, the metallic pollution substances, which are found in living organisms, reach to high level of contamination in animals that are being nourished by concentrated feeds and grazed on pasture at contaminated fields. Contamination level of heavy metals in animals is dependant upon type, age and ration content of animals[7,47].

Table I. Average Concentrations of Heavy Metals Determined at Various Food Substances in United Kingdom.

Group	Aluminum	Arsenic	Cadmium	Lead	Mercury
Bread	6.6	0.005	0.028	0.02	0.002
Meat	0.4	0.003	0.0008	0.006	0.001
Offal	0.43	0.004	0.077	0.09	0.005
Meat Products	1.9	0.003	0.0097	0.011	0.003
Poultry	0.3	0.004	0.0025	0.005	0.002
Fish	6.1	4.4	0.013	0.02	0.043
Egg	0.14	0.0009	0.0004	0.003	0.0013
Milk	0.07	0.0004	0.0002	0.001	0.0004
Milk Products	0.5	0.002	0.0011	0.008	0.002

Heavy Metals

Aluminum

Aluminum level is varies 1.9 and 4 μg/l in biological liquids, 0.005 and 0.5 μg/l in tissues, 5 μsg/m^3 in air and 3 μg/l in water[19].

According to EPA, daily aluminum necessity of animals is 5000μg/l supplemented by drinking water. Adult humans need aluminum between 2.5 and 13 mg/day by means of foods or other sources.

The event of being poisoned by aluminum is generally a chronic toxic characteristic. Aluminum, taken by low quantities together with other foods, does not cause any disorder in metabolism[42,26]. However, when it is taken higher amounts, it results in changes in phosphorus metabolism, muscle weakness, growth recession, micro-cytic anemia, osteodistrophi resistant to Vitamin-D, rickets, memory weakness, talking and voice disorder, progressing brain damage, Alzheimer disease and kidney disorders. Additionally, excessive aluminum intake causes cardio-toxic A), embryo-toxic and teratojenik effects as well[29].

The serum and urine aluminum-chromium Al/Cr) ratio is found quite high in diabetic patients compared to healthy persons. It is likely reason is that chromium, which is an essential element in glucose metabolism, and it shows great similarity to aluminum on the basis of chemical characteristics. It is assumed that excessively taken aluminum results in diabetic induction and deterioration of diabetic[3].

Arsenic

Arsenic is a metalloid, which has been wide spread and average level is 5 ppm in cultural earths, between 0.1 and 100 ppm in agricultural products and cultural plants, between 0.0002 and 0.005 ppm in seawaters and between 0.5 and 1.0 ppm in drinking water[18,21]. According to EPA, maximum arsenic amount that animals should obtain together with drinking water is 200μg/l. The level of arsenic in earth changes between 1 and 40 ppm. Average arsenic quantity in human body is between 10 and 20 mg and dangerous limit is 6.1 ppm[8,18].

Arsenic toxicities happen at winged animals due to usage of high level of antioxidant and growth increasing prescriptions, such as arsenic acid, roxarson, nitarson, carbarson. Arsenic causes the hypoxia formation in tissues together with bleedings in veins by replacing with phosphorus in winged animals and stopping oxidative reactions in cells[1].

High amounts arsenic intake is important in cancer etiology. The risk of cancer for workers who works in insecticide production, metal industry and wine warehouses, and for the persons using arsenic contaminated waters continuously are increased. According to studies, it has been suggested that inorganic arsenic, which is taken through digestion system, causes skin-cancer, urethra-cancer, and liver-cancer. Furthermore, uptake of arsenic through inhalation also causes lung-cancer. International Cancer Research Centrum has explained that inorganic arsenic components are the responsible to skin, urethra and lung carcinogens[9,15,30].

Mercury

Important objects of living organisms are mercury components, elementary mercury, organic mercury, inorganic mercury 1 and mercury 2 salts together with their components. Organic mercury components are methyl-ethyl and phenyl mercury components. Methyl mercury components play an important role on food substances and sediment[45].

Mercury is toxic particularly for organisms living in water. Average mercury concentration is between 20 and 50 in seawater, 70 ng/l in river water. According to EPA, maximum mercury level needed in drinking water of animals is 1μg/l. According to WHO-FAO organization, tolerance level of mercury is 0.05 ppm and this level is 0.5 ppm in USA and Canada and 0.7 ppm in Italy. It has been stated that maximum exposure limits are 0.01 ppm and 0.1 mg/m^3,[17].

Mercury causes especially memory losses and talking troubles, since it has strong effect on central nervous system. It causes inflammation and color disorder in palates together with its toxic effects on urology system[17].

It has been founded that irreversible genetic disorders and carcinogenic effects, which happen as a result of taking continuous and low amount of mercury, have been formed. It is particularly known that, methyl mercury causes mental disorders and malfunctions in fetus since it can pass through the placenta barrier easily. Also, it is definite that elemental mercury vapors and methyl mercury causes neuron-toxicity by effecting the central nervous system and methyl mercury inhibits prostaglandin cyclooxygenase cycles, which is important on prostaglandin synthesis depending upon its dosage. It has been announced that continuous usage of mercury-cosmetics causes membranous nephropathy and mothers using these cosmetics result in disorders in their babies such as renal, ocular and hematological system[2,11,14,36,43]. In our country, there are limited studies on determining mercury residue amounts within food substances. According to the studies, mercury levels has been determined as 0.0134 ppm in chicken-meat, 0.02 ppm in its liver, 0.24 ppm in kidney and 0.014 in egg in Bursa-Turkey[47]. Senavci et al.[49] reported that average mercury levels were 0.030 mg/ kg in chicken liver and 0.023 mg/kg in kidney tissues from various slaughtering and markets Ankara and Bursa between the years 1992 and 1994.

Cadmium

Cadmium absorption by animal bodies is dependent upon the absorbing animal's type, structure of cadmium component, taken quantity, age and effect of other food substances. Animal's cadmium absorption is related to quantity of this metal within earth and fertilizing type. Cadmium can exhibit its affect in a chronic and acute manner. Acute affect is dependent upon cadmium's form, solubility and high concentration, which may be taken[52]. WHO-FAO has announced its tolerance level for adults as between 0.06 and 0.07 mg/day 1 ppb).

European Community has defined the maximum cadmium limits for livers and kidneys of winged as 0.5 mg/kg and 1.0, respectively. According to NRC[35], cadmium exposure limit is 0.05 mg/m^3. It has been informed that cadmium limit is 0.05 ppm for muscle tissue, 0.001 ppm

for fat of winged animals and 0.000 for skin of winged animals[10]. According to Directives of European Community, the maximum cadmium limit for meat of winged animals is between mg/kg[31]. The residue level of cadmium has been measured between 0.3 and 1.2 ppm in chicken liver and kidney by the study made by Canadian authorities regarding cadmium residue levels in animal sourced food substances[47].

The cadmium absorption levels have been determined by studies on daily-consumed foods performed by various countries. After these studies, this level has been found out as 18 mg/day in Belgium, 20 mg/day in Holland, 56.31 mg/day, 17.1-25.4 mg/day in Korea. Various countries have defined cadmium tolerance levels for limiting cadmium absorption together with taken foods[4,44,51].

The levels of cadmium and lead contamination in the vegetables and feeding stuffs, produced in the areas where are far from the industry, traffic and urbanization, were less than the those that were closer to the heavy traffic and industrial activities[32].

The effects of cadmium, exerted on living organisms, are similar to the effects forming as a result of iron and zinc deficiencies. Illnesses of anemia, bone marrow hiperplacy, and cardiac hypertrophy have similarities with zinc deficiency and hipoplacy have similarity with iron deficiency. These effects are the result of effects deforming metabolisms of essential tracing elements, not due to the toxic effect, which are exerted directly on cells. Taking cadmium with little doses causes mal-absorption by deforming duodenum absorption. In Japan, a bone degeneration named Itai-itai formation has occurred, due to absorption of Vitamin-D and Calcium by women consuming rice contaminated with cadmium[16,50].

Lead

The lead, which is found in all sorts of natural environment and organisms, isn't an essential element for physiologic life. The lead causes food pollution as the result of spreading of lead components, which are used in paints' compounds as pesticide, consumed widespread for operation of natural sources and industrial needs[47]. The permissible tolerance level of lead in animal is higher than the level permitted for humans. According to EPA, the necessary lead level in animal's drinking water is 100 μg/l[5].

The lead level has been found as 0.5 – 2.0 ppm in chicken's liver and kidney by the studies, which have been performed for the sake of determining the lead residue levels in animal foods. It has been announced that the lead content has been determined in chicken's liver as 0.07 ppm and in chicken's kidney as 0.06 by a study realized in Canada[47].

According to studies performed for the sake of determining the lead levels of daily taken lead by total diet, this value has been determined as 179 mg/day in Belgium, 114.77 mg/day in Spain and 88.1 mg/day in Korea. WHO organization has defined the weekly lead absorption level as 3 mg/person. The lead tolerance level is 2 ppm in Canada[4,44,51].

If calcium level becomes low in foods, the lead absorption and accumulation amounts reach to toxic levels. The lead concentration in skeleton is noticed in soft tissues and has a toxic effect, although it is ineffective as physiologic. In case of an infection or pregnancy, the calcium, which is mobilized from bones, can come out the symptoms of being poisoned by lead suddenly by carrying along the lead[24,41,47]. The lead, which has cumulative effect on the organism, exerts toxic effect against nervous system and hematopeic system. Furthermore, it gives considerable damages to livers and kidneys. The lead causes congenital abnormalities and postnatal nervous behavior abnormalities by passing through placenta.

It is considered as normal, if lead concentration is less than 40 μg/l in human blood. Although these amounts have no significant effects on children, it may form harmful effects on normal behavior and perception functions. If the lead level reaches to 40-80 μg/l in blood, then anemia nervous symptoms and kidney damage may happen[33,47]. Gaga has taken blood samples from children living in Bursa's City Centrum and Gölyazı Region separately and found out that the lead concentration is 5.12 μg/dl in children living at City Centrum and 4.56μg/dl in children living in Gölyazı Region. According to the researches performed in Mexico regarding the effect of high concentration of lead exposure, which happens to pregnant women, against the fetus; a positive relation has been found between spontaneous abortions and blood lead levels. It has been informed that they have determined a lead concentration of 10-25 μg/dl in bloods of the women, who have faced with fetus losses[20].

It is possible to be exposed against high concentrations of cadmium and lead in various business fields. It has been pointed out that it has

been determined increases on the risk of prostate and lung tumors as the result of exposures of cadmium oxide dusts that workers working in factories, where nickel-cadmium accumulator and copper-cadmium alloys in United Kingdom. It is stated that there is an increase on the deaths resulted due to being poisoned by cadmium, since these workers have been exposed to cadmium oxide dust and fumes. The cadmium levels have been determined as 4 $\mu g/m^3$. within these oxide fumes[23,48].

Conclusion

Preventing this pollution isn't so probable due to present status of industrial urbanization and agricultural activities. Heavy metal residues, which have been spread out the environment, become harmful not only for humans, animals and plants but also they cause for a lot of troubles connected into each other within that environment, by destroying the ecological balance.

The toxic metals, which are taken together with water, foods and air, have a tendency for accumulation. The risk of being poisoned for humans by the metal residues as the result of consuming meat of cattle/ship or meat of chickens is arisen by eating the meats of animals fed by polluted feeds.

In developed countries, sold food substances are controlled by taking regular samples periodically and levels of toxic metals and other polluters are measured in control laboratories. If the concentrations of mercury, cadmium and lead are found as exceeding their tolerances, then consumption of that food is prohibited.

In our country, there is an obligation of applying the precautions and sanctions, proposed by applicable laws for control of sources, which are the reason of environmental and food pollution. The foods should be controlled with the viewpoint of residues and contaminations such as heavy metals, beginning from its production and ending with its consumption. Furthermore, workers of industrial sector and agriculture together with people should be ensured to become conscious on the subject of dangers reflected to community health due to environmental pollution.

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