ISSN No:-2456-2165

Toxic Heavy Metals Dangerous For Life and the Problems Related to Them

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Abstract:- Toxic heavy metals appear to be one of the large groups of inorganic substances polluting the environment, the negative action of which becomes a burden for the population of the planet. Because of technical revolution, the biosphere became so contaminated that human's life occurred under the threat. Recently in the television program, there was information about the high content of toxic heavy metals in food products and spices and their toxic influence on living organisms. So, we decided to inform the population about the distribution of toxic heavy metals and their negative influence on living organisms.

Keywords:- *Mercury, Lead, Neurological Pathologies.*

I. INTRODUCTION

According to Knorte Stress Index (1974), among the contaminating substances the heavy metals, as toxic substances take the third place. Some representatives of heavy metals, such as cobalt, chromium, copper, magnesium, iron, molybdenum, manganum, selenium, nickel and zinc are widely involved in the process of digestion of animal food, as well as in some physiological and biochemical processes and in case of their deficit, disease syndromes are often observed. However, in case of excess amount an acute and chronic toxicosis maybe developed. Heavy metals enter the human organism from food, water, and soil in sufficient quantities. Many representatives of heavy metals easily dissolve in lipids, resulting in their intracellular accumulation. Despite the low content of heavy metals in the organism of animals living in rivers and lakes, because of deposition in the organism, their content will increase ten times or more. There are three main pathways for the distribution of heavy metals: abiotic (wind erosion, water circulation), biotic (food products) and anthropogenic (fertilizers, pesticides, industrial emissions, etc.). Mercury and lead have especially high toxicity. Among the heavy metals mercury and lead are distinguished by especially high toxicity.

The heavy metals are especially dangerous because of food proteins binding by sulfhydryl groups, resulting in disturbances of protein functional activity and the inactivation of some enzymes. Under such conditions at the expense of increased free radicals, the neurotoxic state is especially acutely revealed. Because of enhanced oxidative processes, the structure of lipids, proteins and DNA is damaged, and due to it, the metabolism is disturbed, which can lead to the most serious pathologies, the development of malignant tumor and even the death of humans. It is noteworthy that as a result of frequent touch the mutation of nucleic acids is also observed, the action of endocrine system is disturbed, which can lead to the development of a malignant tumor [1-4].

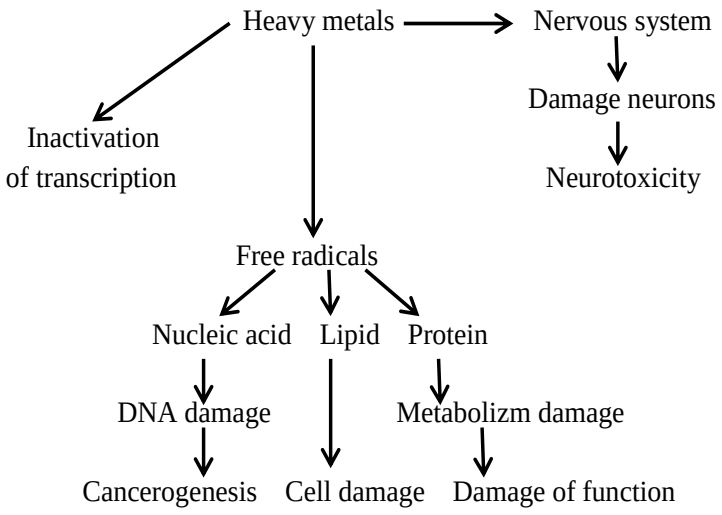

Fig. 1. The impact of heavy metals on the biochemical transformations taking place in the organism.

ISSN No:-2456-2165

It has been established that because of ecological pollution of the environment, the accumulation of heavy metals in living organisms enhances, for example, the concentration of mercury in oysters and bivalve mollusks appears to be 10.000 and more, than in the waters where they live. In the fish that we use for food, the amount of heavy metals is high enough and most of them are accumulated precisely from those waters. Especially dangerous are those fish that live in the ponds and not in the running waters. The accumulation of excess amount of heavy metals is observed in the swampy soils of ponds.

Despite this, today everyone is talking about the harmful effects of lead, but the most dangerous among heavy metals is mercury, because it appears to be a volatile substance and just its vapor is especially harmful to living organisms. Unfurtunately, the spread of mercury in the nature is increasing. The excess amount of mercury accumulates in lakes, which are less renewable. For example, in some lakes of Sweden the fishing was prohibited because of high content of mercury. The content of mercury in fish from the lakes contaminated with mercury appeared to be seven times higher, as compared to those living in mercury-free lakes (700 μg/kg).

In 1956 in one of the regions of Japan total of 292 people were infected for unknown reasons, 62 of them died. During the disease, paralysis of the limbs, difficulty moving and vision impairment of patients were observed. Only after seven years it was revealed that the reason for that was the Japan Firm "Nipon Risso", flowing on the seaside the industrial residues rich in mercury. Because of that the firm was forced to flow these residues into the river Minamata (hence the name of this disease "Minamata"). After that this mysterious disease was observed among the fishermen living in the riverside areas. By means of chemical analysis it was finally determined that the disease was caused by methyl-mercury, an amount of which was 100 shares per million organic matter of this waste solution.

Annually, the release of mercury only from the earth's crust into the atmosphere in the form of residues makes up several hundred tons. In the form of vapor, it spreads over long distances in a state linked with a variety of particles, which eventually sediments in the soil and waters. It is supposed that one of the reasons of decrease in the number of sea birds and seals in North Sea is due to the accumulation of large amounts of mercury in the organism. liquid mercury is less toxic and despite the absorption, it easily releases from the organism. Notwithstanding the above, children should not be allowed to play with mercury, as the inhaling of its vapor is dangerous. After the inhalation, mercury from the lungs moves to the blood, passes hematoencephalic barrier and then it enters the brain, leading to serious neurological disorders. Intensive release of mercury vapor takes place during the production of metals and cement, in the process of mercury-containing herbicides production, during the burning of coal and oils, as well as from the residues of accumulators and batteries, etc.

In case of the poisoning with mercury vapor, the functioning of central nervous system and neuromuscular transmission are disrupted, the action of many enzymes containing –SH groups is inhibited. While poisoning with mercury vapor, spotting and loss of the teeth, decrease in the immune system and strengthening of susceptibility to infections are observed. The memory and orientation reactions are impaired. Sometimes, during an acute poisoning with mercury vapor, a person fails even to find the way to his own house. At oral injection of pregnant rats with 0.2-0.5 mg of methylated mercury, it soon appeared in the placenta and fetus. Facial anomalies in newborns were noted. Strong deviations were revealed also at chromosomes level depending on the concentration of various alkyl compounds of mercury and the duration of its exposition.

As "tooth amalgam" mercury was used for tooth filling. But soon its use for teeth treatment was forbidden as mercury was evaporated in the oral cavity and made some problems for a human health. It is noteworthy that a release of mercury vapor into the atmosphere during cremation appeared to be very dangerous, as at high temperature amalgam decays and a release of mercury as a vapor takes place.

In dirty sediments of rivers and lakes, especially in oxygen free area, a mercury ion (Hg^{2+}) produced because of the action of anaerobic micro organisms, binds covalently to methyl anion and liquid dimethyl-mercury ($Hg(CH_3)_2$) is produced. Methylcobalamin and vitamin B_{12} appear to be a source of methyl group. Dimethyl-mercury quickly evaporates from the water, until it is converted to monomethyl. On the water surface dimethyl-mercury undergoes photodegradation, the generated yet unknown products are deposited on the bottom of lakes.

Unfortunately, in humans the mercury is predominantly presented as methyl-mercury and occurs in human organism from fish products. It is due to the fact that by means of gills the fish easily take mercury along with the food.

Older fish have much more methylmercury because of a prolonged contact with it and its accumulation. In lake fish the content of mercury is especially high in acidic waters, due to enhanced methylation of mercury in acidic medium. Because of a high affinity to sulfhydryl groups and a good solubility in lipids, a period of semi-disintegration of mercury in human organism makes up 70 days. According to the established norm, minimal content of mercury in food should not exceed 0.5 ppm.

The WHO concluded that if methyl-mercury content in hair is more than 10-20 ppm, this indicates that in the blood of pregnant women there is already a sufficient amount of methyl-mercury and treatment of the embryo should be started promptly. Such cases are quite frequent in those countries (e.g. Northern Canada), where the population consumes large quantities of fish products.

Organic mercury compounds such as the fungicides are used in agriculture. After contact with the soil, it decays and forms an insoluble form of mercury because of contact with sulfhydryl groups of clay and organic substances.

As a result of cereal processing with fungicides of methyl-mercury type, hundreds of people died in Iraq and America. In Sweden and Canada because of cereal processing with methyl-mercury, the quantities of birds significantly decreased. At present the use of methyl-mercury as the fungicides in agriculture is strictly prohibited in Southern America and Western Europe. It was established that at the content of Hg^{2+} in hair, the impairment of vision and other disorders were observed in humans.

From mountain rocks and earth, mercury naturally passes into water, which often is due to the erosion of rocks and action of humans on them. During irrigation of plant areas, mercury can be released in the water. For example, in Quebec and Manitoba during the construction of dams of hydroelectric power plants, a fairly large number of methyl-mercury, which was generated from mercury occurring in the soil, was released from the surface of recently flooded soil. A part of it was synthesized because of anaerobic bacteria at the expense of Hg^{2+} released from the soil.

Out of mercury compounds, phenyl-mercury (C_6H_5-Hg^+), which is used to make white dyes, is also of particular interest. Phenyl-mercury appears to be quite toxic for humans, as after its decay Hg^{2+} is released. Because of its antiseptic and protective abilities, some compounds of mercury are used in pharmaceutical industry and cosmetics [5].

As to lead, the facts of its poisoning was known still 150 years ago BC. The ancient Greek doctor Nicander of Colophon described some symptoms of people with lead poisoning. In the opinion of some historians, a crucial role in collapse of the Roman Empire had namely dishes made of lead. And indeed, according to the latest data, in the bones of the Romans a lead content appeared to be 100 times higher as compared to Americans. According to WHO, a standard norm of lead content in drinking water is 10 billion shares.

Lead content in the atmosphere is rapidly growing. Because of it, many countries all over the world got interested in the development of such technologies, which significantly would reduce its content in the atmosphere and soil. In recent years such measurements were successfully implemented in many eastern countries.

Lead is easily processed and one can give it any form. In antique times, lead was successfully used as construction material. The Romans used lead for the manufacture of water pipes and dishes. The analysis of Greenland Icebergs had established that a content of lead in the ice was the highest in the times of Roman Empire, as compared to the Renaissance period. Today along with tin, lead is successfully used in building industry for metals bonding, for making gunpowder, etc. There are frequent cases when birds as a result of swallowing lead, fired while hunting become victims of lead poisoning. In the Northern America the loons (diver bird) died after swallowing a lead float during fishing.

Lead itself makes no problems for the environment until a soluble ion is formed from it. Ionic lead creates ionic sulphides PbS, $Pb^{2+}S^{2+}$. Elemental lead, as an electrode, despite its contact to sulphuric acid, is stable and is successfully used in lead batteries. It is not desirable to take water or other food that has been stored for a long time in a lead or glazed dishes. The standard norms of the content of heavy metals in drinkable water are given in the Table 1.

Table 1. The standard norms of the content of heavy metals in drinking water according to the data of World Health Organization (WHO)

Metal	**WHO**
As	10 ppb
Cd	3 ppb
Pb	10 ppb
Hg	1 ppb

ppb - unit share of Billion

After the strengthening of transit routes between European and Asian countries, due to the use of lead-containing petrol, the problem of lead diffusion in the air and soil along the highways became more acute. As known, the population mainly settled along the roads. Today situation is the same with the difference that traffic has increased and a content of lead significantly increased in plants, air and soil along the highways. It is noteworthy that it is very dangerous to get food and graze the cattle within 500 meters from the road. In present conditions these norms are violated and nobody knows about the negative results we would receive in future. It is known that at the content of 8 µg of lead in 1 liter of blood, a decrease in hemoglobin and the number of erythrocytes in human blood is noted. Such shifts in children are revealed even at the presence of 4 µg of lead. At chronic poisoning with lead a hypertension develops, which is due to kidney damage.

According to the newest data, using lead-content poor quality petrol, lead-content in the soil and plants on the territories near the highways significantly increases. At lead excess, dust grains become sterile, a process of fertilization reduces, and the cases of chromosome failure are often observed. Many European cities, as well as those in Georgia (Rustavi, Gori, Khashuri and Tbilisi), which are overloaded with transport are especially contaminated with heavy metals. Unfortunately, in 2004 according to the Internet information, Tbilisi was considered to be as one of the contaminated cities. The data of British Company - Technology have shown that it is due to technical malfunction of cars and low-quality petrol.

When heavy metals are used in the industry and for various types of production, during the process of material burning, a large part of them is dispersed into the air, ponds and waters flowing into the soil. Noteworthy are also industrial products, such as cosmetic substances,

ISSN No:-2456-2165

pesticides, herbicides. Unfortunately, the distribution of heavy metals can occur as a result of erosion and acidic rains.

It is noteworthy that even in natural concentration of lead (<1 μmol/kg) its negative impact on the organisms is noted. In the conditions of 20 μmol/kg lead concentration, because of sulfhydryl groups binding, Ca^{2+} transport is inhibited, resulting in erythrocytes lysis. At the impact of lead dust, gastric acidity reduced and the development of malignant gastric tumor was often noted in typography workers. The bones appear to be one of the strong deponator of lead. At high lead concentration, the process of ossification, vitamin D metabolism are disturbed, bone decalcifiction and increase of their fragility are observed. At lead excess in the blood of humans and animals, a sterility and the inhibition of spermatozoids movement, as well as premature labor and often even death are noted. As it has been found, in conditions of excessive amount of lead in the blood, a mentality of children decreases, short-term memory, reading skills and even alphabet memorizing impair.

Taking into account the results of experiments carried out by biochemists and physiologists and according to the law adopted in 1972, petrol manufacturers reduced a content of lead to 0.4 mg in 1 liter of petrol. Because of it, lead amount in the atmosphere of the cities reduced by 68%. However, lead absorbed by plants will stay in the cities and along the highways for many more years. Currently, the norms of lead content in food products are established, which are quite different in various food products (μg/kg): fish products - <1.0, meat and meat products - <0.5, fruit and drinking juices - <0.4, bread and bakery products - <0.2, milk and dairy products - <0.05. Therefore, it is natural that a strict control over the lead content in food products should be established.

Lead content has been detected in ethylated petrol and dyes, which precipitate and are stored in the soil for many years. The presence of lead is observed in glazed ceramic dishes, from which lead can get into food because of storage in a clay pot. Lead content was also detected in children's toys, made abroad. While using cosmetics for eyes made in Nigeria, cases of lead poisoning were observed.

Lead poisoning has been linked to traditional Hispanic medicines - Greta and Azarcon, as well as to some from India, China and other countries. Tamarind, an ingredient used in some candies made in Mexico, might contain lead. Time spent at firing ranges can lead to exposure. People are exposed to lead and can bring it home on their clothes when they work in auto repair, mining, pipe fitting, battery manufacturing, painting, construction and certain other fields [6].

At present, there is a lot of talk about lead content in children. Because of it, an attention should be paid to the treatment of people poisoned with heavy metals. For treatment of people who have been poisoned with heavy metals, those substances are successfully used, which have higher affinity to heavy metals, as compared to enzymes and total proteins. While processing the organism with such substances, the solubilization of heavy metals from the organism and their complete elimination become possible. One of such compounds is British Anti-levisite (BAL) that contains two -SH groups and which binds heavy metals with maximum affinity and is excreted from the organism in soluble form with the urine. For this purpose ethylenediaminetetraacetate (EDTA) is also used, by means of which binding of divalent ions and solubilization easily take place. Then it is excreted from the organism in soluble form with heavy metals. It is advisable to start treatment of people poisoned with heavy metals very soon after the poisoning, until neurological disorders are revealed [2, 5-7].

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