REVIEW

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Cadmium, cadmium toxicity, role of curcumin as detoxifying agent

Cadmium is chemically and physically similar to zinc, and both are often found together in natural minerals and ores. The biggest natural resources of cadmium are located in China, Japan, Mexico, Canada, Kazakhstan, USA, Netherlands, Germany, Russia, Bulgaria, Poland, India, Peru, Australia, Democratic and South Koreas, Brazil, Norway, France, and Argentina.

Cadmium can pose a certain environmental hazard. Legislation has been passed in many countries to reduce the use of cadmium and its spread in the environment [1].

Cadmium has high resistance to corrosion and has been used for a long time for galvanic coating of other metals (bolts, nuts, fasteners and other parts of aircraft and vehicles), as dyes and stabilizers in plastics, and as a heat stabilizer in PVC plastics. Cadmium is increasingly being used in the production of reusable batteries, such as mobile phones. It is found in various inorganic salts, photocells, solar batteries. Cadmium chloride is widely used as a fungicide, as one of the ingredients of galvanic solutions, it is used in pyrotechnics (for color effects), in tinning, in mordanting and dyeing fabrics. Cadmium is used in the production of special mirrors, cadmium is also one of the initial components for the synthesis of PVC heat stabilizers, it is a part of silver alloys, luminescent coatings, semiconductors and enamel for glass and ceramics.

Cadmium enters the soil of agricultural land with mineral fertilizers - superphosphate, potassium phosphate, saltpeter. A high content of cadmium is found in manure, which is due to the cycle: air → soil → plants → herbivores → manure [2,3].

Tobacco products also contain cadmium, which accumulates during the process of cultivation from soil or water, that it contains [4,5]

It is known that Cadmium potentially causes mutations and chromosomal deletions [6], its toxicity includes depletion of glutathione (GSH) [7], inhibits the activity of antioxidant enzymes, and induces oxidative stress and cell death [8].

Long-term exposure to cadmium causes a variety of disorders, such as:

- diseases of the respiratory system, including emphysema [9,10]
- kidney disease (proteinuria, urolithiasis, uremia) [11,12,13]
- cardiovascular diseases (hypertension, atherosclerosis, arterial hypertension) [14,15,16]
- violations of the liver and pathology [17,18,19]
- dyslipidemia [20]
- anemia [21]
- loss of smell (anosmia) [22]
- disorders of bone metabolism [23]
- osteomalakia [24]
- cancer of the lungs, pancreas, kidneys, breast, prostate, bladder) [25,26,27]
- encephalopathy (in children) [28]
- Itai-Itai disease [29]
- diabetes [30,31]

- apoptosis [32,33]
- psoriasis [34]

According to research data, curcumin is one of the best means for preventing the development of pathological processes in the body caused by toxins [35].

Curcumin is the main curcuminoid [36] found in turmeric root [37].
Curcumin is one of the most widely tested natural compounds. Laboratory studies have shown that curcumin is a therapeutically useful tool for preventing or correcting the negative effects of cadmium on the body.

The mechanism of action of curcumin is due to a metal-ligand interaction [38], which reduces the load of heavy metals and their toxic effects on the body. Moreover, curcumin can interfere with the gastrointestinal absorption [39] of cadmium, thereby causing a decrease of cadmium concentration in blood and tissue. This suggests a potential chelating [40] effect of curcumin.

Curcumin also increases GSH [41], normalizes the redox ratio of GSH, induces the expression of gamma-glutamylcysteine ligase [42], a downstream gene of the Nrf2-ARE signaling pathway [43]. Curcumin is a potent regulator of the transcription factor Nrf2 activator and prevents the secretion of IL-6 [44], IL-8 [45] caused by cadmium [46,47,48].

Furthermore, in laboratory conditions curcumin has demonstrated multiple pharmacological properties, including antioxidant, anti-inflammatory, anticarcinogenic, cardioprotective, hepatoprotective, antidepressant, immune-strengthening, and many others [49].

Unfortunately, these encouraging initial findings were not supported in human clinical trials due to the very low bioavailability of curcumin, which averaged no more than 0.1% [50]. This low bioavailability prevents curcumin from showing its therapeutic potential while taking as powder or extract.
It is worth noting that laboratory studies with curcumin have greatly increased interest in it all over the world, and this was especially evident in the segment of dietary supplements. On almost every supplement site, you can purchase preparations made from powder or turmeric extract and find information on the pharmacological effect of curcumin on dozens of diseases.
This method of presenting information is a substitution of concepts, when laboratory findings are issued as clinical results. Neither turmeric extract, nor powder, is able to provide the pharmacological action that curcumin has shown in laboratory research.
Increasing the bioavailability of curcumin has been the topic of many research teams for several decades [51]. Several technologies have already been developed to increase the bioavailability of curcumin. The most advanced technology for the delivery of active substances into the blood is liposomal [52].

Liposomal curcumin delivery technology achieves the desired pharmacological effect in humans and animals, which has been demonstrated in thousands of laboratory studies [53,54].

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