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MINI-REVIEW ARTICLE

Heavy Metals in Wheat Grain and Its Impact on Human Health:

A mini-review

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KEYWORDS

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ABSTRACT: Heavy metals (HMs) form a very varied group of elements that are very diverse in terms of chemical properties and biological functions. Heavy metal contamination in agricultural soil has become a serious environmental problem. These metals are toxic to soil, plants, aquatic life, and human and animal health. These toxic pollutants are caused by natural activities such as volcanoes and mining and smelting metals. These metals are stable in nature, therefore, they accumulate in the soil and agricultural products, and it is necessary to properly understand the relationship between the concentration of heavy metals in the soil and its accumulation in wheat. These metals also interfere with the level of antioxidants in plants and reduce the nutritional value of the product. Consumption of many heavy metals in the diet through the consumption of plants has long-term destructive effects on human health. In this review study, the most important heavy metals in agricultural products, especially wheat, on human health were reported. For this review study, keywords such as Crops, Heavy metal, Human health, Wheat flour were used. The databases searched for in those articles were Google Scholar, SID, Scopus, PubMed, Science Direct, and ISI search engines. Given that bread is the dominant force of the Iranian people, so the quality study of wheat in the country's consumer market in order to maintain the health of consumers seems necessary. Therefore, we need to inform people about this, so this review article explains the presence of HMs in bread and its disadvantages.

INTRODUCTION

Cereals products composition a key role in the human diet. Cereals, especially wheat, may have a high nutritional value for human life, accounting for roughly ¼ annual cereal production, wheat supplying 70% of the world's food. Wheat *(Triticum aestivum)*, the most widely used for human consumption. Wheat is a principle food of the human daily diet [1]. As the dominant food in Iranian diet, wheat contains more than 50-90% of calories and protein [2]. The most popular kinds of bread in Iran are *sangak, lavash and taftoon* which are made of flour. It has overwhelmingly been shown that intake bread in Iran is 420 grams per person, and in the USA, Western Europe, Russia and Turkey, 55,274, 164 and 400 grams per person, and the average in the world is 330 to 410 grams per person [3]. In opinion of the broad delivery of grain into the following fractions: 20% bran, 5% pollard and 75% flour,

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Though, they might characterize a source of complexes with unique physio-chemical, nutritional and functional properties [4]. One of the greatest challenges within food security and food safety is heavy metal. Evidence suggests that contamination of heavy metal is a fundamental concern for food safety in Iran and globally [5]. Heavy metal has always been and still continues to be a risk associated with wheat product consumption [6]. Previous studies have been indicated that even at low concentrations, are their physiological effects on vital and toxic organisms. Heavy metals has been widely recognized through natural resources such as soil, dust in the atmosphere, snow and rain, and human resources such as greenhouse gas emissions from industrial facilities, the use of mineral fertilizers, sludge and compost residues of entering the food [7-9]. A number of studies have been reported that elements such as lead (Pb), cadmium(Cd), Arsenic (As), Mercury(Hg), Silver(Ag), Selenium(Se), Chromium(Cr) and Nickel(Ni) accumulate in various parts of the body, including the liver and kidneys, bones, lungs and other parts of the body are common disorder characterized by neurological disorders, respiratory distress, cardiovascular, abortion, immune suppression, and acute deaths (Table 1) [9, 10].

Table 1. Effects of HMs on human health [11, 12]

Metals	Health effects	Uses
Arsenic	Cancer, nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet. Darkening of the skin and the appearance of small "corns" o "warts" on the palms, soles, and torso.	Paints, drugs, soaps and semi-conductors.
Cadmium	Carcinogenic, Stomach irritation, vomiting and diarrhea, Kidney damage, lung problems, bone fragility	Batteries, pigments, metal coatings, and plastics.
Lead	Carcinogenicity, nervous system disorders, weakness in the fingers, anemia, hypertension. Abortion, infertility in men, serious brain damage, kidney and death.	Batteries, ammunition, gasoline, paints, and pipe solder.
Chromium	Human carcinogens, Irritation of the nasal mucosa, ulcers and runny nose, respiratory problems such as asthma, cough and shortness of breath. Skin problems such as allergies, redness and severe swelling of the skin. Liver, kidney and nerve tissue injuries.	In stainless steel; Magnetic tapes and pigments are used for paints, cement, paper, rubber and its soluble state in wood preservatives.
Mercury	Carcinogenicity, brain, kidney, nerve damage, mutagenesis, tremor, lung damage, hypertension or heart rate, irritability, eye irritation and skin problems.	Production of chlorine gas and caustic soda, thermometers, dental fillings, switches, lamps and batteries.
Nickel	Carcinogenicity, pulmonary fibrosis and pulmonary problems, heart problems, skin allergies, embryonic nephrotoxicity, allergic reactions and contact dermatitis.	Production of durable alloys, stainless steel, use in transportation such as milk trucks, in processing equipment such as dairy, containers such as wine tanks, kettles, beer barrels, production of household appliances such as knives, bowls, spoons and forks, in the production of powder packaging , Dentures, car exhaust fumes, industrial waste processed foods, fertilizers, hydrogenated oils and stainless steel containers.
Silver	A disease called Arigria, respiratory problems, irritation of the lungs and throat, and stomach pain, skin problems such as swelling and inflammation.	Manufacture of jewelry, silverware, electronic equipment and dental fillings, solder alloys, photographic film, silver nitrate as a disinfectant and silver nitrate in cloud seeding to produce rain.
Selenium	Nausea, vomiting and diarrhea, major symptoms of hair loss selenosis, brittle nails, and neurological abnormalities, respiratory tract irritation, bronchitis, difficulty breathing and stomach pain, respiratory irritation, bronchospasm and cough.	Electronics industry, glass industry, in rubber, paint and ink; In the preparation of medicines as a feed additive for poultry and livestock and as a food supplement. In the formulation of pesticides in rubber production; As a substance in anti-dandruff shampoos, Fungicides.
Barium	Vomiting, abdominal cramps, diarrhea, respiratory problems, high or low blood pressure, Changes in heart rhythm or paralysis and possibly death.	Making candle electrodes, creating green paint in fireworks, use in drilling sludge, paint, brick, ceramic, glass and rubber.

Lead and cadmium are toxic and dangerous elements among the heavy metals in food. The toxicity of Pb and Cd to human and animal (0.20 mg/kg Cd for wheat, bran, germ and rice, vs. 0.10 mg/kg, and Pb (0.20 mg kg^{-1} for unprocessed cereals) [13, 14]. The concentration of heavy metals in wheat products in some countries is shown in Table 2.

Table 2. Concentration of heavy metals in wheat products in some countries

Country	Product	Cd mg kg^{-1} dry weight	Pb mg kg^{-1} dry weight	As mg kg^{-1} dry weight	Ni mg kg^{-1} dry weight	Cr mg kg^{-1} dry weight	Ref.
Iran	Lavash Bread	0.65	0.42	ND	0.47	-	[2]
Egypt	Wheat	0.131	0.398	-	-	-	[15]
Saudi Arabia	Gluten-free Foods	2.9–6.6	1.4–10.5	0.09–0.66	0.35–0.46	4.7–100.3	[16]
Canada	Whole wheat soft	0	0.001	0.002	-	0.001	[17]
Iran	Wheat	0.041	0.43	-	-	-	[18]
Iran	Lavash Bread	0.3	-	0, 0.2	0.7	0.9	[3]
China	wheat grain	0.006-0.179	0.017-1.158	0.029-0.086	0.043-0.637	0.027-0.799	[19]
China	wheat grain	0.06	0.14	-	0.28	0.47	[20]
China	wheat grain	0.01	0.03	-	0.09	0.11	[21]

Given the importance and high consumption of bread and the disadvantages of HMs on the health of the human body, it is necessary to inform the public about this issue, so this review article explains the presence of heavy metals in bread and its disadvantages. Studies show, the application of HMs by plants be determined by on the acidity of the soil. In root crops, leafy vegetables and parts of plants that grow near the soil are more at risk of metal contamination than higher parts of plants. [11, 22, and 23].

Walker *et al*., stated Ni roles in biological systems and yield that increases in field grown crops in reply to Ni application to the crop and to the soil. The role of Ni in urea metabolism in plant [24]. Riaz *et al.*, reported that patterns of Cr^{+3} and Cr^{+6} uptake and translocation in wheat [25]. Cr (III) in small quantities is essential for humans and elemental animals. The body needs chromium (50-200 micrograms per day) to maintain normal glucose metabolism. Lack of it causes heart problems, metabolic disorders and diabetes, but overdose can cause poisoning, diarrhea, vomiting, and itchy skin [26]. Radiana *et al.* showed that Pb concentration in the pollard and bran was higher than concentration in grain, flour [27]. Oliver *et al* revealed Cd concentration in the pollard and bran were higher than in grain, flour and semolina [28]. Akinyele et al., (2015) presented Ni levels to range from 0.06 mg/kg to 0.14 mg/kg in the cereals [29]. Kamboj *et al.*, demonstrated that Nickel is also one of the most vital element required in very low concentrations. It is highly responsible for enhancement in plant growth and various other associated growth components [30]. Shahid *et al.*, found Cr is mostly the minimum mobile in the rhizospheric root followed by the translocation to leaves and then fruits [31]. Awan *et al*., reported that the concentration of cadmium was detected in wheat grains irrigated with fresh water 0.9317 mg/kg and irrigated with wastewater 1.153 mg/kg, but in both irrigation conditions, the cadmium content was higher than the standards which contradicts our study and the standard suggested by FAO/WHO [32].

Khan *et al;* shown that, the usage of wastewater due to the accumulation of HMs in the food products caused toxicity in humans. The only solution to address the health concerns of using wastewater is to treat it before irrigation [33]. Dai *et al*, stated Accumulation of heavy metals in food endangers human health, especially children [34]. Zhang *et al*, Showed that Cu, Cr, Ni, Pb and Hg were present in soybeans, which could threaten people's health if soy consumption was higher than the usual dose [37]. Yang *et al*, reported that, showed that the source of nickel is mainly

from industry, where the rest of the metals are mainly obtained from agricultural activities. Guo *et al*, suggested that children absorb more heavy metals than adults and that they are more vulnerable to the side effects of these metals [38].

Bread is the dominant force of most people in the world, especially Iran. Contamination of bread with heavy metals causes harmful effects on human health and it is necessary to determine the amount of heavy metals in the breads used [39-41]. When high levels of heavy metals enter the body, they accumulate in the kidneys, liver, bones, and brain, disrupting the function of that part of the body. Some heavy metals are carcinogenic, and some only affect the body's ability to produce red and white cells. In fact, every heavy metal affects a part or parts of the body. For example, a heavy metal may not cause any side effects through skin contact, even when swallowed, it does not cause serious harm, but inhaling the vapor of that heavy and toxic metal can cause severe lung damage [40-43]. Cadmium is toxic to the body. Its destructive effects on the kidneys, liver, bone density, infertility, bone fractures, damage to the central nervous system, damage to the immune system, mental disorders and possible damage to DNA and cancer [41,42]. Lead contamination prevents the synthesis of hemoglobin, damage to kidney function, reproductive system, joints, cardiovascular system, acute and chronic damage to the central nervous system and lateral nervous system [40-42]. Mercury enters the body through ingestion, inhalation, skin absorption, and eye contact, causing damage to the liver, brain, respiratory system, skin, eyes, and central nervous system. Silver causes skin allergies for some people [39-44]. Barium reduces blood potassium, causes cardiac arrhythmias, hypertension, respiratory failure, gastrointestinal disorders, muscle pain and kidney damage, and neurological diseases [30-44].

CONCLUSIONS

In general, heavy metals enter soil and agricultural products through various activities such as industrial and natural activities. Hence, these metals enter the food chain and endanger human health. For this reason, the government is advised to control water, soil, and all activities to ensure the safety of agricultural products to reduce the potential risks of heavy metals entering the food chain.

Author's contribution

All authors contributed equally to the manuscript.

Conflict of interests

The authors declared no competing interests.

ETHICAL CONSIDERATIONS

Ethical issues (including plagiarism, data fabrication, double publication and etc.) have been completely observed by author.

Findings/support

None.

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