A STUDY ON THE DETECTION OF HEAVY METAL CONTAMINANTS IN FOOD

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Abstract

Food has always been one of the most important part of our livelihood. And with food, is related food toxicology, which can be due to different sources. From the ancient times and till now, consumer getting the right product is at the utmost priority. And thus, the system evolved and contaminants that were unavoidable got attention to be removed from our food. And so, it helped metal contaminants such as lead, mercury, cadmium, tin and arsenic to be traced and removed completely. This study aims to determine the adverse effects of heavy metals like tin, cadmium, lead, mercury on food quality. Elevated health issues have driven scientific research which consider the consumption of heavy metals in daily dietand healthassessment study of Kolkata is one of them, which includes dietaryadmission of metals from most widely recognised nourishment items were assessed by increasing their utilization rate with the mean concentration of metals found in them. Further research aboutmetal contamination in food brings light to legislation and various codes of practice set by FAO and WHO. With development, many measures helped to bring a brighter future. Metal detectors came into play and helped the food processing industries. Discussed below are the metal contaminants, their effects, sources and legalities; with some of worldwide known cases of metal detection.

Introduction

Metal contamination of food products is a major concern of food manufacturing industries. Even withthe strongest metal detection techniques, metal contamination still occurs. As always, for safety purpose; the goal of the studyis to reduce the metals to an acceptable level where total elimination is not possible. And, thus metal detection plays a vital role in safe food production. Metals are typically solids that are ductile, malleable, lustrous and electrically conducting.

Among many metals one consumes through our diet, only a small amount is essential for normal life; classified in categories of micronutrients and macronutrients. Food contains a wide

range of metals like sodium, magnesium, copper etc. but these are essential in trace quantities. Apart from these, the important ones for food manufacturing is toxic metals. It is very difficult to consider a metal toxic, but still we can understand elements known to be essential and others causing severe toxicity at lower concentration with no beneficial functions. Metal are generally one of the unintentionally added contaminants of food. They get into foods through different means of air, water, soil, industrial pollution. Metals present in more than a standardquantity is dangerous, and is called to be toxic. Beryllium, Cadmium, Lead and Mercury are listed in the category of toxic metals. Generally, human activities like farming or industrial work leads to higher level of metal contaminants. Also, it can be due to intermediate steps while food processing or storage. Heavy metals, having high atomic mass, accumulated in our ecosystem causes food contamination and are then ingested by humans and animals and then they get accumulated in biological tissues. Excessive amount of these can detrimental to organisms.

Lead and mercury cause effect on brain and intellect development in young children, while long exposure of lead cause damage to kidneys, reproductive systems and also the nervous systems. Tin causes gastrointestinal irritation and upsets. Cadmium is also toxic to kidneys. Also, inorganic arsenic is of concern due to its cancer-causing properties. The negative impact of these metals can't be ignored. Future studies of the detection of metals are needed to minimize their amount, whenever exceeding the acceptable limits. Foods like brown rice and leafy green vegetables are high in metal contaminants than other foods. There are many sources from which these metals enter the food chain, be it soil or any food processing equipment, metallic cleaning tools etc. Also, there can be other routes of contamination as well like migration from packaging (e.g. antimony from plastic bottles and tin in canned foods). In many food industries, magnets are used to eliminate some metals from foods and detectors are used to detect the presence of metals in foods. Hence, metal detectors are used to protect consumer and also the machinery involved in the process. The detectors work on the principle of electromagnetic induction and help in bringing the level of contamination to knowledge. They contain one or more inductor coils that are used to interact with metallic elements in the food. Each metal has a specific limit dependent on the food type, as set by the legislations. In all conditions, safety if the primary concern and thus, limits are usually set at about 100 times below the level at which toxicity is noticed.

Toxicological effects of metals on food quality and human health

There are many toxicological effects of metals on the quality of food. But it depends on the chemical form in which the metal is involved such as mercuryin

elemental form and inorganic salts are much less toxic than the organic mercurial. Mercury is dangerous for human health. Fish taken from contaminated water (by industrial use) provides methyl mercury in diet. Cadmium too is one of the most extensively used metal in industries and becoming a major environmental pollutant. After ingesting cadmium, it makes a metal-protein complex and get stored in kidney. Its long-term exposure leads to variety of malfunction like liver dysfunction etc. Contaminants like lead affects the kidney and arteries that tends to shorten life. It causes pathological pain and severe disease like muscular paralysis and brain damage. Tin also effect the food quality. It enters the food chain, as a variety of containers are made up of tin plate and are used for strong processed foods. Canned foods after opening sometimes develop a metallic flavour due to acidity that is unpleasant to taste.

Health assessment study in Kolkata:

Determined dietary admission of metals from the ingestion of five of the most widely recognized nourishment items consumed by the grown-up occupants of Kolkata were assessed by increasing their utilization rate with the middle concentrations of metals found in the individual nourishment things. When all is said is done, aside from lead, the day by day consumption of Arsenic, Copper, Chromium, Manganese and Zinc through the utilization of rice, red lentil, vegetable, fish and chicken were seen as less than the most extreme average day by day consumption values.

The admission of lead from the utilization of nourishment things could be of wellbeing worry to the grown-up populace. Rice, vegetable and fish contributed to the greatest burden Arsenic, Copper, Chromium, Zinc, Lead and Nickel admission in the day by day dietary admission of nourishment. Arsenic (68%), Zinc (86%) and Lead (96%) originated from the utilization of rice and vegetables. 99.57% of Arsenic originated from the everyday admission of rice, vegetable and fish. One of the essential wellsprings of fish and vegetables to the Kolkata markets is the in sewage-took care of lakes and rural farmlands in and around Kolkata. Also, the nearness of Arsenic, Chromium, Manganese and Lead in these nourishment things might be because of this. The territory of West Bengal is additionally known for broad defilement of groundwater with arsenic, just like its neighbouring nation of Bangladesh. From the health risk assessment studies, it was found that the intake of above-mentioned metals through rice, red lentil, vegetable, fish and chicken was less than the maximum tolerable daily intake values.

Toxic diseases caused by heavy metals

Heavy metals, when ingested through food, accumulates in time and causes damage to body. Several diseases can be caused by toxic metals. Some of them are given below: -

Aluminium associates with Parkinson's disease, presenile dementia, Alzheimer's and senility.**Nickel** damages lung, liver and kidney.**Cadmium** causes hypertension and damage to kidney.**Chromium** causes cancer and damages lungs.**Lead** and **Mercury** may cause joint disease of kidneys, nervous system and also the circulatory system.**Arsenic** cause abdominal pain, cancer and black foot disease.

Sources of metal contamination

There are many sources for contamination of food by metals. Soil is the primary source of most metals, by which food is produced. It's contribution towards the metal contaminants is quite considerable. So, sources of different metal contamination is given below.

Traces of metal nutrients required by plants for their growth are supplied by soil. These can be copper, iron, manganese, molybdenum. Metals like cobalt, cadmium and lead are toxic and they can also be taken up by the plant through soils. Metals like lead counts many sources which provide absorption of it by human system. It includes contaminated water, leaded dust in air, contact with machines, equipment, packaging etc. Contaminated with lead. Arsenic is a heavy metal and its ingestion in human diets is greatly influenced by the consumption of sea food. Primary source of dietary mercury is fish. The sources of cadmium exposure to general population are water, tobacco, food. Contamination of water is often due to cadmium alloys in galvanized water pipes.

Cases of metal contamination in food

There are many cases related to metal contamination in foods. After many surveys, food examined was said to be having metal contaminants. Some of the cases/ survey results are given below:

Studies in 2006 by Industrial Toxicology Research Centre, Lucknow, found carcinogenic nickel, lead, chromium and cadmium in silver foil used for different sweets and pan masala. They made aware that only a purity of 99.9% in silver foil is acceptable for edible forms.

In 2015, high amount of lead content and mono-sodium glutamate (MSG) was found to be in instant noodles of a popular brand; and concerns led to destroying it in huge quantities for not meeting the food safety standards.But the product later, at a government lab, cleared all tests and was available again with high percentage capture in the market.

In a study **in 2016,** soft drink samples were found to be having lead and other heavy metals.Because of leaching of toxins from bottles, lead, cadmium and chromium were detected.Mainly, this could be due to contaminated ground water that these heavy metals are entering food products and beverages.

Recently, a new report from consumer advocacy group reported that toxic metals like lead, arsenic, cadmium and mercury are found in 95% of the 168 commercial baby foods tested. Rice

based cereals and snack, sweet potatoes and juices were top in the list. And even small amount of these contaminants is dangerous for a developing brain and child's IQ level.Also, **Indian Council of Medical Research** conducted a **survey** and it resulted in knowing high levels of arsenic and cadmium in infant formula canned products and turmeric. **Nickel** is a trace metal and is carcinogenic and its levels are high in Indian chocolates. Nickel enter in chocolates through milk and other ingredients.

Laws regarding metal contamination in food

When finally, food became a product of commerce, regulations were made. Majorly, lead, copper, zinc, arsenic, tin, cadmium, mercury, chromium and nickel are found in the food as the metal contaminants, and for providing safety to the consumers, fssai prescribed laws related to its permissible limit in ppm (parts per million by weight) across different products.To set the maximal limits for any contaminant, information like how toxic is the metal and what is technologically available, costing and the limits of quantification are looked upon.Adulteration through inert material or fraudulent additions was practiced and thus, laws and legislation were very important for giving a product of nature and quality as demanded by the consumer.

According to UK legislation's Food Safety Act in 1990, a maximum of 1mg/kg is set for both arsenic and lead in unspecified foods, while for tin, it is 200mg/kg for any food.Use of Aluminium is permitted for decorating sugar confectionary like cakes, pastries as an outer coating.

In US legislation, Codex sets the maximum limit as 40ppm for all the heavy metals, 10ppm for lead and 30ppm for arsenic.

According to the Codex standards, the permissible limits are:

Metals	Maximum Limit in mg/kg
Arsenic	0.1
Lead	0.1-1
Mercury in natural mineral water	0.001
Tin in canned beverages	150

Tin in canned fruits and vegetables	250
Cadmium	0.05-0.2

Food stuffs	Maximum level (mg/kg) wet weight

For Cadmium-

Meat of bovine animals, sheep, pig	0.05
Horsemeat (excluding offal)	0.2
Liver of bovine animals, sheep, Horse, pig, poultry	0.5
Kidney of bovine animals, sheep, pig, horse	1.0
Muscle meat of fish	0.05

For Tin:

Canned food other than beverages	200
Canned beverages, including fruit and vegetable juice	100
Canned baby foods and cereal-based foods for infants	50
Canned infant formulae (infant milk and follow on milk)	50
Canned dietary foods for special medical purpose, for infants	50

For Lead:

Meat of bovine animals, sheep, pig, poultry	0.1
Cereals, legumes, pulses	0.2
Muscle meat of fish	0.3
Fats and oils including milk fat	0.1

Food supplements	3.0

Apart from the national and international rules set by different governing bodies, there are some strict codes of practice by bodies like FAO and WHO to make it even safer and stricter to get a safe food product in the marketplace worldwide.

Conclusion

Metals, when present in more quantity is dangerous and are termed as toxic. After getting into our body through food, they get accumulated in the biological tissues and then can be detrimental to organisms and thus can't be ignored. Metal contaminants are having an easy access in our food through different processing techniques and other sources. Their extent in different types of foods are discussed above in the study. Contaminants like mercury, lead, cadmium, tin etc. affect the human health that tends to shorten life and leads to secondary effects too. Soil, being the major source make it very difficult to eradicate metals from our food. But still, metal detectors (works on the principle of electromagnetic induction) came to the rescue and helps in reducing food toxicology. Also, the government made many laws for regulation of processing of food. According to the UK legislation, the Food Safety Act (introduced in 1990) limits the use of metals like arsenic, lead, mercury etc. Also, governing bodies like FAO and WHO made strict codes to get a safer product for consumers. To conclude, metal in foods should not be acceptable above the maximal limits set in the laws, because their presence above it is dangerous. Consumer safety is the upmost priority for any food processing company and thus, metal detectors should be used.

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