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HEAVY METALS CONTAMINATION AND DETECTION BY USING INDUCTIVELY COUPLED PLASMA OPTICAL EMISSION SPECTROSCOPY: A REVIEW

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ABSTRACT

Heavy metals are necessary for human health, and are beneficial when taken in to the body in foods or as supplements at appropriate, low levels but can be toxic when taken in higher concentrations. Heavy metals are contaminated through various sources like herbal medicines, drinking water, wastewater, solid waste, soils. Contamination of heavy metals in herbal medicines includes through agricultural soils and irrigation water from industrial waste disposal and some are also added during the preparation of the raw materials. Exposure to heavy metals such as arsenic, cadmium, lead, nickel, zinc, iron, copper, chromium and mercury are highly poisonous can cause acute and chronic toxicity, like reduced mental and central nervous function and damage to vital organs. Long-term exposure may lead to physical, muscular, and neurological degenerative processes that mimic Alzheimer's disease, Parkinson's disease, and so on. Since safety continues to be a major issue with the contamination of heavy metals, it becomes imperative, therefore, relevant regulatory authorities put in place appropriate measures to protect public health. Hence it is necessary to study the levels of metals being consumed by us, in daily life and further consequences can be evaluated. Among different analytical techniques, inductively coupled plasma optical emission spectroscopy is a versatile tool for detection and quantification of elements in accurate manner in terms of sensitivity, precision and accuracy. ICP-OES is one of the sophisticated analytical techniques used for multielement analysis of trace metals in water, food, soil and herbal medicines.

KEYWORDS: Heavy metals, Herbal medicines, ICP-OES.

INTRODUCTION

Heavy metals are generally defined as metals with relatively high densities, atomic weights, or atomic numbers. 'Heavy metal' is a widely-used term for elements with metallic properties. Another description often used interchangeably with heavy metals is 'trace elements'. These are natural constituents of the earth's crust, but indiscriminate human activities have drastically altered their geochemical cycles and biochemical balance. This results in accumulation of metals in plant parts having secondary metabolites, which is responsible for a particular pharmacological activity. These elements occur naturally in rocks and in variable amounts in soils, depending on their location and the rocks that have broken down to make the soil's components. The group 'heavy metals' for the purpose of discussing health risks or impacts generally includes:

- Arsenic (As)
- Lead (Pb)
- Cadmium (Cd)
- Chromium (Cr)
- Copper (Cu)
- Mercury (Hg)
- Nickel (Ni)
- Zinc (Zn)

Several of these elements are necessary for human health, and are beneficial when taken in to the body in foods or as supplements at appropriate, low levels. Conversely, cadmium, lead and mercury have no known biological function and are toxic to humans.

Sources of heavy metal pollutants

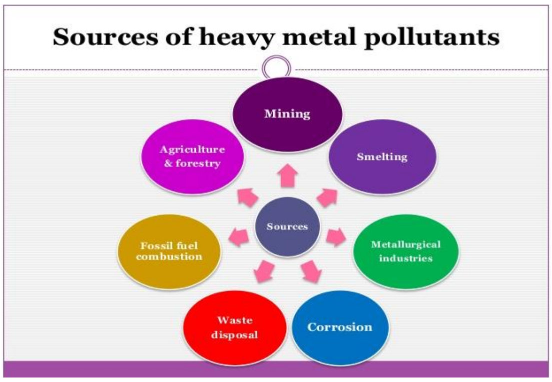
Soil acts as a repository for many heavy metals that human activity releases into the environment. This may protect the wider environment to some extent by 'locking away' heavy metals and preventing them reaching other parts of the environment, such as water supplies. However, the soil itself may then present a risk to those who live or eat crops grown on it. Some soils have naturally high levels of heavy metals and, in some cases, plant species able to take up and store large amounts of heavy metals have evolved in these locations. Metal concentration in soil typically ranges from less than one to as high as 100,000 mg/kg. Irrespective of the origin of the metals in the soil, excessive levels of many metals can result in soil quality degradation, crop yield reduction, and poor quality of agricultural products, posing significant hazards to human, animal, and ecosystem health.

Heavy metal contamination through vegetables is also one of the most important sources to be considered. Vegetables are rich sources of vitamins, minerals, and fibers, and also have beneficial antioxidative effects. However, intake of heavy meta-contaminated vegetables may pose a risk to the human health. Heavy metal contamination of food is one of the most important aspects of food quality assurance.

Worldwide debate is on for the use of ayurvedic metallic preparations. According to World Health Organization, the use of herbal medicines has increased tremendously over the past three decades with not less than 80% of people worldwide. Herbal medicines are sometimes contaminated with toxic heavy metals such as lead, arsenic, mercury and cadmium, which impose serious health risks to consumers. The presence of heavy metals in herbal/natural products is due to several possibilities like contamination of the agricultural soils and irrigation water produced from industrial waste, mining activities and the usage of certain types of fertilizers. Heavy metals are also added during the preparation of the raw materials for herbal products which covers many steps such as cultivation, harvesting, collecting, cleaning and drying of the medicinal plants. The other possibility is the accidental contamination during the manufacturing processes used in different steps.

Heavy metals disrupt metabolic functions in two ways

1. They accumulate and thereby disrupt function in vital organs and glands such as the heart, brain, kidneys, bone, liver, etc.
2. They displace the vital nutritional minerals from their original place, thereby, hindering their biological function. It is, however, impossible to live in an environment free of heavy metals. There are many ways by which these toxins can be introduced into the body such as consumption of foods, beverages, skin exposure, and the inhaled air.



Arsenic

Arsenic is found throughout the Earth's crust, generally in the form of arsenic sulfide, or metal arsenates and arsenides. Arsenic is a metalloid used since ancient times both as a poison and for medicinal purposes. Although its use has declined with time, arsenic trioxide is being used for treatment of acute promyelocytic leukemia.

Sources of arsenic exposure

According to WHO research from south-east Asia, humans may be exposed to inorganic arsenic through soil, air, water and food. This typically includes children ingesting soil, ingesting certain traditional medicines and foods, and ingesting water. In soils in this region, arsenic is present at levels between 0.2 and 40 (μg/g) of soil. The levels of arsenic in food in affected countries vary, but a far greater threat is considered to be arsenic in drinking water.

Arsenic can be released into the atmosphere and water by:

- Natural routes, including volcanic activity, minerals dissolving - particularly into groundwater, exudates from vegetation, and windblown dust
- Human activity, such as mining, metal smelting, fossil fuel combustion, pesticide production and use, and treating timber with preservatives
- Remobilisation of historic sources, such as mine drainage water
- Mobilisation into drinking water from geological deposits, e.g. by drilling wells.

Health effects of arsenic exposure

An estimated 30 million people may be at risk from arsenic-related disease as a result of contaminated water in some regions. Arsenic poses serious short and long-term threats to health, and so efforts to reduce exposure to arsenic from all sources are important. When individuals are exposed to arsenic over the longterm, the first changes are usually in skin pigmentation, followed by lesions and hard patches on the hands and soles of the feet. The long list of other long-term exposure effects includes peripheral neuropathy, gastrointestinal symptoms, conjunctivitis, diabetes, renal damage, an enlarged liver, and bone marrow depression, destruction of red blood cells, high blood pressure and cardiovascular disease.

Long-term arsenic exposure - for more than ten years - can cause cancer, particularly of the skin, bladder and lungs, and possibly of other organs, such as the kidneys, liver and prostate. Because arsenic can pass through the placenta, pregnant women exposed to arsenic through drinking water are at greater risk of miscarriage, stillbirth and pre-term birth, and there is evidence that exposure to arsenic in the womb or in early life increases the risk of lung cancer and other lung disorders. Inorganic arsenates in drinking water have a much higher acute toxicity than organic arsenates. The acute minimal lethal dose of arsenic in adults is estimated to be 70 to 200 mg or 1 mg/kg/day.

Cadmium

Cadmium (Cd) is a naturally occurring metal situated in the Periodic Table of the Elements between zinc (Zn) and mercury (Hg), with chemical behavior similar to Zn.

Cadmium (Cd) is an extremely toxic industrial and environmental pollutant classified as a human carcinogen [Group 1 – according to International Agency for Research on Cancer;[11] Group 2a – according to Environmental Protection Agency (EPA); and 1B carcinogen classified by European Chemical Agency.

Sources of cadmium exposure

Around 90% of cadmium exposure in non-smokers is through food. Crops take in cadmium from soils and the rate of uptake is influenced by factors such as soil pH, salinity, humus content, crop species and varieties and the presence of other elements (e.g. zinc). Some population groups are especially vulnerable to increased exposure and uptake of cadmium:

- Vegetarians or individuals who consume large amounts of cereals and pulses are likely to have higher exposure than the general population, as agricultural crops (especially irrigated rice) account for most of the cadmium intake
- Those with a high intake of shellfish and organ meat from marine animals may have a particularly high intake of cadmium
- People with low body iron stores, especially pregnant women, or low zinc intake have higher rates of cadmium uptake
- Smokers: tobacco plants absorb cadmium from soil. Non-smokers may also be affected through passive exposure to secondary smoke
- People living in the vicinity of industrial sources and other point sources of cadmium release can be exposed to an increased level of cadmium.

According to available data, the average weekly intake of cadmium from food in most countries is within the range of 0.7–2.8 µg/kg body weight (UNEP, 2010). Given their smaller size, children may be taking in more cadmium per kilogram of body weight than adults.

Health effects of cadmium exposure

Acute exposure to cadmium fumes may cause flu-like symptoms including chills, fever, and muscle ache sometimes referred to as "the cadmium blues." Symptoms may resolve after a week if there is no respiratory damage. More severe exposures can cause tracheo-bronchitis, pneumonitis, and pulmonary edema. Symptoms of inflammation may start hours after the exposure and include cough, dryness and irritation of the nose and throat, headache, dizziness, weakness, fever, chills, and chest pain.

Inhaling cadmium-laden dust quickly leads to respiratory tract and kidney problems which can be fatal. Ingestion of any significant amount of cadmium causes immediate poisoning and damage to the liver and the kidneys. Compounds containing cadmium are also carcinogenic. The bones become soft, lose bone mineral density and become weaker. This causes the pain in the joints and the back, and also increases the risk of fractures. In extreme cases of cadmium poisoning, mere body weight causes a fracture.

The kidneys lose their function to remove acids from the blood in proximal renal tubular dysfunction. The kidney damage inflicted by cadmium poisoning is irreversible. The proximal renal tubular dysfunction creates low phosphate levels in the blood, causing muscle weakness and sometimes coma. The dysfunction also causes gout, a form of arthritis due to the hyperuricemia. The kidneys can also shrink up to 30%. Cadmium exposure is also associated with the development of kidney stones. These were features of itai-itai disease, first described in Japan in the 1940s among people who had eaten rice grown on fields irrigated with cadmium-polluted water.

Copper

Copper is an essential trace element that is vital to the health of all living things. Copper plays a major role for proper functioning of organs and metabolic processes.

Sources of copper exposure

Copper is found in mineral supplements, hard water, hot tubs and swimming pool chemicals, cookware, the birth control pill and other estrogen medications like birth control side effects, copper IUD's, dental materials, brackets and jewelry, cooking utensils, piping, fungicides, industrial emissions, insecticides, oysters, chocolate, refrigerator ice makers, some city water, and well water.

Health effects of copper exposure

Copper toxicity is particularly disturbing to the body and mind because of its effect on zinc. Zinc is an extremely important nutrient and a deficiency has a wide range of consequences. Zinc is used up rapidly under stress, and when stimulants such as coffee, alcohol and sugar are used.

Zinc is a sedative, calming mineral for the brain. When copper becomes high, zinc levels drop, increasing the stimulating effect of copper on the mental functions. GABA, an inhibitory, calming neurotransmitter, is zinc dependent. The ideal ratio of copper to zinc is 1:8 in favor of zinc.

Copper builds interferes with proper conversion of thyroid hormone at the cellular level. It also disturbs zinc balance, interfering with adrenal hormone production and this weakens the immune system. The impairment of both thyroid and adrenal gland function causes the most common copper toxicity symptom, fatigue. It inhibits cortisol production which causes hypoglycemia and increased inflammation, and increases aldosterone production which enhances brain activity and can give a feeling that the mind is racing. Copper toxicity, also called copperiedus, which refers to excess of copper in the body. Acute symptoms of copper poisoning by ingestion include vomiting, hematemesis, hypotension, melena, coma, jaundice, and gastrointestinal distress. Chronic effects of copper exposure can damage the liver and kidneys.

It is stimulating and irritating to the nerves and can lead to headaches including migraines, neuralgia, such as sciatica or trigeminal neuralgia, and other neurological conditions such as epilepsy and tremors. It causes joint pain and arthritis, digestive problems, irritable bowel, overgrowth of candida albicans, breathing difficulties including asthma, and chronic skin problems which can range from acne to psoriasis.

Lead

Sources of lead exposure

Lead-based paint and lead-contaminated dust in older buildings are the most common sources of lead poisoning in children. Other sources include contaminated air, water and soil. Adults who work with batteries, do home renovations or work in auto repair shops also might be exposed to lead. Lead is also found in automobile exhaust, canned fruit juices, car batteries, crayons, hair coloring, air pollution, mascaras.

Health effects of lead exposure

Lead poisoning occurs when lead builds up in the body, often over months or years. Even small amounts of lead can cause serious health problems. Children younger than 6 years are especially vulnerable to lead poisoning, which can severely affect mental and physical development. At very high levels, lead poisoning can be fatal. Epidemiological studies show that exposure to lead during the early stages of children's development is linked to a drop in intelligence. Studies suggest that for each 10 µg/dl (microgram per decilitre) of blood lead, IQ is reduced by at least 1-3 points (Morgan, 2013. See also Canfield et al, 2003; Chen et al, 2005). Children are particularly at risk from adverse effects of lead exposure because: Intake of lead per unit of body weight is higher for children than for adults, Young children often place objects in their mouths, resulting in the ingestion of dust and soil and, possibly, increased intake of lead and Physiological uptake rates of lead in children are higher than in adults.

At high levels of exposure, lead attacks the brain and central nervous system to cause coma, convulsions and even death. Lead exposure also causes anaemia, hypertension, renal impairment, immunotoxicity and toxicity to the reproductive organs. The neurological and behavioural effects of lead are believed to be irreversible.

There is no known safe blood lead concentration. But it is known that, as lead exposure increases, the range and severity of symptoms and effects also increases. Even blood lead concentrations as low as 5 µg/dL, once thought to be a "safe level", may be associated with decreased intelligence in children, behavioural difficulties, and learning problems.

Mercury

It is commonly known as quicksilver and was formerly named hydrargyrum. A heavy, silvery d-block element, mercury is the only metallic element that is liquid at standard conditions for temperature and pressure.

Sources of mercury exposure

Usually the greatest percentage of harmful exposure to mercury for humans is through eating fish, especially sea fish tuna. Besides leaking from mercury amalgam fillings, cosmetics, pesticides, paint, plastics, fungicides, fabric softeners, adhesives, floor waxes/polishes, laxatives, suppositories, tattoos, hair dyes, batteries and of course broken mercury thermometers, cement production, mining and smelting, artisanal and small-scale gold mining, burning coal and oil refining are some of the activities emitting mercury which can build up in soils.

Health effects of mercury Exposure

Exposure to methylmercury, the most harmful form of mercury to human health, affects brain development, resulting in a lower IQ, and consequently a lower earning potential. High level exposure to methylmercury is known as Minamata disease. Methylmercury exposure in children may result in acrodynia (pink's disease) in which the skin becomes pink and peels. Long-term complications may include kidney problems and decreased intelligence. The effects of long-term low-dose exposure to methylmercury is unclear. Once methylmercury is formed, it cycles though the environment for thousands of years, exposing humans and other species to potentially toxic levels for generations. The US FDA and the EPA advise women of child-bearing age, nursing mothers, and young children to completely avoid swordfish, shark, king mackerel and tilefish.

Zinc

Zinc is an important mineral required for a number of functions involving energy and metabolism. It is critical in supporting the immune system, which protects us from pathogens, infections, and disease. Zinc also plays a role in carbohydrate breakdown process that supplies energy, as well as in cell growth, division and reproduction.

Sources of zinc exposure

Zinc is a metal with common industrial applications, such as in paints, cleaners, solvents, and other construction materials. Zinc can also be found in rubber, varnish, dyes, and rust-proofing agents.

Health effects of zinc exposure

Exposure to significant amounts of zinc can be extremely hazardous and result in poisoning. Overconsumption of zinc supplements can also cause zinc poisoning. Zinc is essential to healthy copper metabolism. Zinc toxicity interferes with normal copper absorption. Such toxicity levels have been seen to occur at ingestion of greater than 225 mg of zinc. Excessive absorption of zinc can suppress copper and iron absorption. Zinc is an essential trace metal with very low toxicity in humans. The high doses of zinc causes symptoms like nausea, vomiting, pain, cramps and diarrhea may occur. There is evidence of induced copper deficiency, alterations of blood lipoprotein levels, increased levels of LDL, and decreased levels of HDL at long-term intakes of 100 mg Zn/d. The USDA RDA is 15 mg Zn/d.

Supplemental zinc can prevent iron absorption, leading to iron deficiency and possible peripheral neuropathy, with loss of sensation in extremities. Zinc and iron should be taken at different times of the day due to its cross reaction toxicity.

Chromium

Chromium is a first chemical element in group 6. Chromium occurs in the environment primarily in two valence states, trivalent chromium (Cr III) and hexavalent chromium (Cr VI). Trivalent chromium ion is an essential nutrient in trace amounts in humans for insulin, sugar and lipid metabolism. Hexavalent chromium is toxic and carcinogenic.

Sources of chromium exposure

Exposure may occur from natural or industrial sources of chromium. Occupational exposure generally occurs through inhalation and dermal contact and in general, people are exposed most often by ingestion through chromium content in soil, food, and water. The entry routes of chromium into the human body are inhalation, ingestion, and dermal absorption.

Health effects of chromium exposure

Chromium as pure metal has no adverse effect. Little toxic effect is attributed to trivalent chromium when present in large quantities. Both acute and chronic toxicity of chromium are mainly caused by hexavalent compounds. The most important toxic effects, after contact, inhalation, or ingestion of hexavalent chromium compounds are the following: dermatitis, allergic and eczematous skin reactions, skin and mucous membrane ulcerations, perforation of the nasal septum, allergic asthmatic reactions, bronchial carcinomas, gastro-enteritis, hepatocellular deficiency, and renal oligo anuric deficiency. Prevention of occupational risks, biological monitoring of workers and treatment of poisoning are also reported.

Nickel

Nickel is a hard, silvery-white metal whose strength, ductility and resistance to heat and corrosion. Nickel is a metal, commonly used to make coins, magnets, jewelry, stainless steel, electronics, and components of industrial machines.

Sources of nickel exposure

Plants are the main source of nickel. Plants growing in soil contaminated with nickel can contain large amounts of nickel. The richest nickel foods are nuts, peas, beans, chocolate, soy, lentils, oats, buckwheat, barley, corn. Fruits that contain nickel are in bananas and pears. Food of animal origin is a poor with nickel, but nickel can be also found in drinking water.

In addition to nickel in food, non-food sources of nickel are coins, jewelry, glasses frame, various household appliances, etc. A certain amount of nickel enters the body through the skin. Canned fruit contains higher amounts of nickel than fresh fruit. This occurs due to fruit reacting with tin, which releases nickel. In addition, during cooking, oxalic acid in some foods attacks stainless steel skillets releasing nickel.

Health effects of nickel exposure

Symptoms of nickel toxicity include skin rash (called nickel dermatitis), nausea, dizziness, diarrhea, headache, vomiting, chest pain, weakness and coughing. Contact with nickel vapor can lead to swelling of the brain and liver; degeneration of the liver; irritation to the eyes, throat and nose; and various types of cancer. Chronic exposure has been connected with increased risk of lung cancer, cardiovascular disease, neurological deficits, developmental deficits in childhood, and high blood pressure. Nickel exposure introduces free radicals which lead to oxidative damage and may also affect the kidneys and liver.

Analytical methods for detection of heavy metals

Since safety continues to be a major issue by accidental consumption of heavy metals, it is necessary to study different levels of these metals and results can be further evaluated. Commonly used sensitive analytical techniques, for detection of heavy metals in herbal medicines includes atomic absorption spectrometry, inductively coupled plasma mass spectrometry, inductively coupled plasma optical emission spectrometry, X-ray fluorescence spectrometry, high-performance liquid chromatography, differential pulse polarography, neutron activation analysis and anodic stripping voltammetry.

Inductively coupled plasma optical emission spectroscopy

Theory

The first commercially available ICP/OES instrument was introduced in 1974. The ICP is now not only the most popular source for OES but it is also an excellent ion source for inductively coupled plasma mass spectrometry (ICPMS). ICP/OES is a proven commercial success, and the future is still bright for ICP-based spectroscopic techniques. Detection limits have improved by a factor of four to six orders of magnitude for many elements.

ICP-OES Characteristics

Among the above mentioned different techniques, ICP is a versatile tool for detection and quantification of elements in accurate manner. The ICP technique is based on atomic spectrometry. Most specifically, the ICP – OES is emission spectrometric technique that exploits the fact that excited atoms emit energy at a given wavelength as the electrons return to their ground state.

During analysis the sample is decomposed by intense heat into a cloud of hot gases containing free atoms and ions of the element of interest. The high temperatures cause significant amounts of collisional excitation and ionization of the sample atoms. Once the atoms or ions are in their excited state, they can decay to lower states through thermal or radioactive (emission) energy transitions. A given element emits energy at specific wavelengths peculiar to its chemical character. The intensity of the energy emitted at that wavelength is proportional to the amount of that element in the analyzed sample.

ICP – OES has additional advantages over the other techniques in terms of detection limits as well as speed of analysis. In ICP – OES sample experiences temperatures estimated to be in the vicinity of 10,000 K. these results in atomization and excitation of even most refractory elements with high efficiency so that detection limits for these elements with ICP – OES can be well over and order of magnitude better than the corresponding values of other techniques. The limit of quantification values of most of the elements in ICP – OES is parts per million and even parts per billion. In number of analytical applications speed can be an important factor. Those advocating simultaneous ICP–OES regard it are the only method worth considering for this task because it analyses so much of sample in minutes. In other techniques like ion exchange chromatography, capillary electrophoresis stabilization is a time taking process and sensitivities are low when compared with ICP – OES. The titration methods are not accurate especially while estimating the elements at lower concentrations and also errors could be expected.

Some of the important characteristic sources are as follows:

- High temperature (7000–8000 K)
- High electron density (10^{14}–10^{16} cm^{-3})
- Appreciable degree of ionization for many elements
- Simultaneous multielement capability (over 70 elements including P and S)
- Low background emission, and relatively low chemical interference
- High stability leading to excellent accuracy and precision
- Excellent detection limits for most elements (0.1–100 $ngmL^{-1}$)
- Wide linear dynamic range (LDR) (four to six orders of magnitude)
- Applicable to the refractory elements
- Cost-effective analyses.

In ICP/OES, the number of elements that can be determined is related to the wavelength window that can be covered by both the collimating and the dispersive optical system.

Wavelengths above 500nm should be used when alkali metals need to be determined, whereas wavelengths below 190nm or even below 160nm should be used when elements such as chlorine, bromine, nitrogen, arsenic must be determined.

According to Senila et al, described in research article ‘validation and measurement uncertainty evaluation of the ICP-OES method for the multi-elemental determination of essential and nonessential elements from medicinal plants and their aqueous extracts’, since all over the world, there are numerous metal polluted sites (European Environment Agency 2007), metals from soil can be transferred to the plants (Moreno-Jimenez et al. 2009; Malandrino et al. 2011; Senila et al. 2012; Rodrigues et al. 2012) and may have adverse effects on consumers' health, as local residents use the plants in their diet, mainly for tea preparation. Consequently, there is a need to develop reliable methods for the determination of metals in medicinal plants and their aqueous extracts. The work was performed a detailed validation of the analytical procedure and estimated the measurement uncertainty budget for determination of some essential (Fe, Mn, Zn, Cr, Cu, Al, Mg) and toxic (Pb, Cd, Ni, As) elements in the medicinal plants and their aqueous extracts. The method was validated according to the international guidelines ISO/IEC 17025:2005 (International Organization for Standardization 2005).

A research article of Vivekanand Vallapragada et al**,** ‘A Validated Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) Method to Estimate Free Calcium and Phosphorus in In Vitro Phosphate Binding Study of Eliphos Tablets’: The method has been validated in terms of specificity, precision, linearity, accuracy and limit of quantification. The validated method can be used to estimate calcium and phosphorus in In vitro studies of not only Eliphos tablets, any generic version of calcium acetate tablets.

According to the review on toxic metals in herbal medicines by Dora Melucci, Marcello Locatelli, they concluded that a petition should be launched and international organizations should unify worldwide to enact a single law in order to codify very low level concentrations of toxic metals in herbal medicines and to bring awareness on semi essential elements if taken in high concentrations can cause serious health effects in humans.

In a research article: 'Development and validation of new ICP-OES Analytical Technique to quantify the contents of Copper, Magnesium & Zinc in Escitalopram Oxalate', a validated and accurate method has been developed to estimate metals in Escitalopram Oxalate drug substance by Mamatha Veeramachaneni, Kumar Raja Jayavarapu.

In a research article of Determination of heavy metals by ICP-OES and F-AAS after preconcentration with 2,2'-bipyridyl and erythrosine, by Feist B et al: The applicability of 2,2'-bipyridyl and erythrosine co-precipitation method for the separation and pre concentration of some heavy metals, such as Cd, Co, Cu, Ni, Pb and Zn in actual samples were determined by ICP-OES and F-AAS.

CONCLUSION

The analysis of drinking water, wastewater, solid waste, soils and herbal medicines for trace metal contamination is an important step in ensuring human and environmental health. With the advanced technologies today, in one elemental analysis run, multiple metals are often analyzed in multiple samples. Depending on the sample throughput, cost, sensitivity/detection limit, concentration range, matrices, and regulation requirements, different instruments can be chosen. For instance, many metal elements can be analyzed easily and economically with ICP-OES. ICP-OES is mainly used for samples with high total dissolved solids (TDS) or suspended solids and is, therefore, more robust for analyzing ground water, wastewater, soil, and solid waste. It can be used for drinking water analysis as well. But in general, ICP-OES is used to measure contaminants for environmental safety assessment and elements with a higher regulatory limit. Trace metal consituents were measured at low and high concentrations in a variety of wastewater reference materials, demonstrating good accuracy. Analyzing multiple samples by using ICP-OES is one of the best methods to improve productivity and efficiency.

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