Heavy Metal Toxicity in Animals

Heavy metals are naturally occurring elements that have a high atomic weight and density, at least five times greater than that of water. Application in various fields have led to their wide distribution in the environment; raising concerns over their potential effects on animal health. Their toxicity depends on several factors including the inclusion, route of exposure, age, gender, genetics and nutritional status of the exposed individuals.

Although heavy metals are naturally occurring elements found in the earth’s crust, environmental contamination and animal exposure result from mining; smelting operations; industrial production and their use; use of metals and metal containing compounds for domestic purposes and in agriculture. Volcanic eruptions also contribute to heavy metal pollution.

![Image Description](http://www.workshop.wp9.biocop2009.uniroma2.it/WP9.html)
Heavy metal bioavailability is influenced by physical factors such as:
- Temperature
- Phase association
- Adsorption
- Sequestration

Bioavailability is also affected by biological factors like:
- Species characteristics
- Trophic Interactions
- Biological/physiological adaptations

The soluble salts of metals dissociate readily in aqueous environment of the biological membrane, thereby facilitating their transport as metal ions. Conversely, insoluble salts are relatively poorly absorbed. Most toxic metals strongly bind to body tissues and accumulate in the body. For example, lead has strong affinity for bone while cadmium and mercury deposit in the kidney.

Essential heavy metals perform physiological and biochemical functions in plants and animals. They are important constituents of many key enzymes and play important roles in various oxidation-reduction reactions. Metals such as Cobalt (Co), Copper (Cu), Chromium (Cr), Iron (Fe), Magnesium (Mg), Manganese (Mn), Molybdenum (Mo), Nickel (Ni), Selenium (Se) and Zinc (Zn), although heavy, are essential nutrients that are required for various biochemical and physiological functions. Inadequate supply of these micro-nutrients results in a variety of deficiency diseases or syndromes. Excess amount of such metals produce cellular and tissue damage leading to a variety of adverse effects.

In biological systems heavy metals have been reported to affect cellular organelles and components such as cell membrane, mitochondria, lysosomes, endoplasmic reticulum nuclei and some enzymes involved in metabolism detoxification and damage repair. Metal ions interact with cell components such as DNA and nuclear proteins causing DNA damage and conformational changes that may lead to cell cycle modulation and carcinogenesis or apoptosis. Because of their high degree of toxicity Cadmium (Cd), Chromium (Cr), Lead (Pb), Arsenic (As) and Mercury (Hg) rank among the priority metals that are of great health significance. They are all systemic toxicants that induce multiple organ damage even at lower level of exposure.

Water pollution by heavy metals has an alarming effect on aquatic organisms (Timmermanetal, 1992). In India, heavy metals like Cadmium, Lead, Mercury, Cobalt etc. and their residues have been reported in water resources (Gupta et al, 2002). Heavy metals in water have proved dangerous and harmful because of their bio-accumulation (Panda & Sahu 2002) and their impact on tissue degeneration. Heavy metal toxicity depends upon the solubility of the ion.
Lead
The toxic effects of lead are produced by a variety of different mechanisms:
- It inhibits the sulphhydril groups of enzymes of cellular metabolism.
- It interferes with Cu, Fe and Zn as prosthetic groups of enzymes in mitochondria thus affecting cellular respiration, oxidative phosphorylation and ATP synthesis.
- It damages blood brain barrier thus causing the cytotoxic effects of solutes in the brain.
- It causes rupture of lysosome and release of acid phosphatase
- It interferes with the flux of solutes such as calcium into and out of brain
- It inhibits Na+, K+ and ATPase enzymes in the RBC and other cells
- It inhibits both adrenergic and cholinergic synaptic neurotransmission (Kostial and Vouk 1957, Cooper 1973)
- It inhibits haem synthesis thus causing haemoglobin deficiency.

The four major targets are the central nervous system, peripheral nerves, kidneys and haemopoietic system.

Mercury
Mercury even at low concentrations inactivates sulphhydril enzymes thus interfering with cellular metabolism and function. Mercury also combines with phosphoryl, carboxyl, amide and amine groups. Both inorganic and alkyl mercury disrupt the integrity of blood brain barrier affecting brain metabolism.

Degenerative changes are widespread in the cell bodies and nerve fibres (Arvind Kumar, C. Bohra). Sensory neurons are severely affected. Various neuro-physiological parameters are altered by mercury. It blocks synaptic and neuromuscular transmission. Kidney is the primary target organ of inorganic mercury. Symptoms of organic mercury are mainly neurological.

Cadmium
Cadmium affects the kidney following either pulmonary or gastro-intestinal exposure (Klassea, 1991). It is associated with cirrhosis of the liver etc. (Higgens and Burns, 1975). In case of oral intake, diarrhoea and abdominal cramps are common.

Arsenic
Symptoms of Arsenic toxicity include staggering gait, collapse and paralysis. Arsenic poisoning is usually acute with major action on gastro-intestinal tract and cardio-vascular system. Symptoms include watery diarrhoea, colic pain, dehydration, skeletal muscle cramps, convulsions and death within 24 hours.

Every year, heavy metal contamination cause huge losses to farmers and the country besides raising grave health concerns in human beings. To address this challenge, Avitech Nutrition Pvt Ltd, a leading animal nutrition company manufacturing feed additives and premixes in India has embarked on a programme to provide farmers with premixes and additives following European Standards for heavy metals.
Avitech is a key supplier of premixes and additives to India, Nepal, Bangladesh and Sri Lanka. It exports specialised feed additives to several South East Asian and African countries. Avitech’s Analytical Division is maintaining a laboratory quality system as per international standard ISO/IEC 17025 and is accredited by NABL. The quality system includes continuous training of its analysts using validated test procedures and maintaining international traceability in standards and analytical instruments being used to ensure reproducible and credible test results.

To implement the programme of controlling heavy metals as per European Standards in its premixes and additives, Avitech has upgraded and augmented the test facility of its analytical division. An Atomic Absorption Spectrophotometer (Make: M/s Agilent, Model: 240 FS) with VGA accessory has been recently installed. Avitech has embarked on the programme to test all batches of incoming raw materials for heavy metals as per European Standards. Avitech has for long been educating vendors in this respect and ensuring raw materials supplied follow European Standards.

**Quality Guaranteed**

In all phases of purchasing, production and distribution, quality and safety are critical. In a complex global marketplace, a weak link can put business at serious risk as ingredients can come from several sources. It is possible to eliminate this uncertainty whenever Avitech’s premixes and products are incorporated.

- All Avitech vendors adhere to stringent qualification standards.
- Protocols for testing and traceability for every raw material used in Avitech premixes are established.

To provide full nutritional benefits to consumers:

- Every batch is sampled, tested for physical and chemical properties.
- All raw materials are examined for particle size, impurities (i.e. heavy metals), assays and potency.
- Established methods are followed to ensure that premixes withstand product processing conditions, achieve shelf-life requirement and performance specifications.

With its long standing experience, growing investment in research, pool of skilled manpower, state of the art laboratory and production facility, Avitech is committed to serving the animal industry with quality premixes and products enabling farmers to provide safe food for mankind. Safe Premix is safe feed is safe food.
To know more about Heavy Metal analysis, please contact:

Avitech Nutrition Pvt. Ltd

GP-37, Udyog Vihar, Sector-18, Gurgaon-122015, Haryana (India)
Ph: +91 124 4011147 / 4278511 / 4278512
Fax: +91-124-4013620
E-mail: marketing@avitechnutrition.com
Website: www.avitechnutrition.com