Biological Times Volume No. 3 | Issue No. 2 | Pages 1-2

Metals Toxicity in Cattle: Focusing on Effective Management Strategies

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ABSTRACT

Heavy metal toxicity has been proven to be a serious risk, and it is associated with several health issues. Heavy metals bioaccumulate in living organisms, they contaminate the food chain and may threaten animals. Heavy metal contamination sources are automobiles, groundwater, animal feed, fertilizers, paints and industries. The nephrotoxic effects of As, Cd and Pb are well known and high levels of naturally occurring atmospheric metals as occupational populations with high exposures have been linked to kidney impairment.

Introduction

Heavy metals in water and animal feed harm animal health because of their bioaccumulation [1]. Few heavy metals including Cd, Pb and As are well known for their toxicity, while other metals such as manganese (Mn), cobalt (Co), zinc (Zn), and selenium (Se) are required in trace amounts for important physiological processes [2]. Cd and Pb have negative effects on physiological and biochemical process when exposed in sub lethal doses. Animals are exposed to heavy metals mostly through the plants, feed, soil, and water they consume because they share the same habitat as humans.

Heavy Metals: Their Toxicity Mechanism and Effects

Lead and its effects on Cattle

Animals are routinely exposed to Pb, one of the greatest environmental poisons in industrialized areas of the world [3]. Accumulated Pb is harmful due to its chemical makeup whether it is consumed and ingested in water or feed [4]. Orally administered Pb is only minimally taken by the host. Because of Pb slower rate of elimination and continued low-level exposure, tissues can accumulate harmful levels of Pb. Young cattle are more susceptible to be harmed because they are more attracted to mineral oils used in automobiles and other products. Acute lead toxicity in cattle and buffaloes affecting important minerals profiles was caused by contamination of pastures and vegetation near lead zinc smelters and battery recycling units [5]. Clinically, poisoned animals frequently show signs of malnourishment, including emaciation, opaque hair, muscle loss, abnormal embryonic development, moderate anaemia, and thickening of the phalange epiphyses [6].

Mechanism of action of lead on kidney

Renal dysfunction may result from lead exposure at high levels (>60 g/dL). Renal impairment comes in two basic forms: chronic and acute nephropathy. Both aesthetically and functionally, nuclear-enclosing bodies, which are composed of Lead protein complexes and degenerative changes in the tubular epithelium, can be utilised to categorise acute nephropathy as a mechanism of reduced tubular transport [7].

Arsenic and its effects on Cattle

Environmental chemical arsenic is also very important to animal health. A significant health danger is posed by environmental contamination. As is a dangerous element that is present everywhere and has increased in concentration in soil and water [8]. It exists in organic, inorganic, trivalent and pentavalent forms and can combine with a variety of elements, such as Lead, Oxygen, Hydrogen, and Copper. Cattle are more vulnerable to Arsenic poisoning than other species. Cattle arsenic toxicity symptoms ranges from nervous system to gastrointestinal including severe gastrointestinal disease, weight loss, severe digestive tract inflammation, unpredictable appetite, mucosal erythematous lesions, decreased milk production and mucosal erythematous lesions [9].

Mechanism of action of Arsenic on kidney

Cattle exposed to Arsenic develop glomerular sclerosis, tubular necrosis, and higher urine NAG concentrations. Arsenic exposure caused DNA oxidative damage and increased renal oxidative stress in cattle. Inflammatory and oxidative stress may also induce kidney injury, however these are very generic pathways [10].

Cadmium and its effects on Cattle

Cadmium is soft silver metal, chemically similar to other two metals in twelve groups. It typically exists in rocks with other elements like chlorine (cadmium chloride), oxygen (cadmium oxide), and sulphur (cadmium sulphide, cadmium sulphate). Cd and other toxic metals are released during mining, sewage treatment, and toxic metals manufacturing [11]. The main sources of cadmium include water pipes, refined foods, coffee, water, tea, burning coal, and burning coal. Commercial uses for Cd include paint pigments, cosmetics, acting as a barrier in nuclear fission, TV screens, galvanizing steel, and lasers [12]. The toxic effects of Cd include hypertension, kidney dysfunction, lung damage, and hepatic injury. Cd is retained for such a long time in storage tissues like the colon, liver, and kidneys in cattle due to sluggish cellular clearance of the metal and the inefficiency of cellular export systems [13].

Mechanisms of Toxicity of Cadmium on Kidney

Cd toxicity has been proved in many organs and Cd induces tissue damage through oxidative stress, epigenetic alterations in DNA expression upregulation and inhibition of transport pathway especially in the proximal S1 region in tubules of the kidney. The kidney is the main organ affected by Cd toxicity and the S1 portion of the proximal tubule is a prime target for Cd deposition. As a result of Cd-induced oxidative damage to carrier proteins and mitochondria [14].

Prevention and Control of Bioaccumulation of Toxic Metals

A physical threat can physically harm an animal or a consumer, therefore safe meat must be free of them (Soil remediation is used to improve the utility of soils, which indirectly reduces the susceptibility of dangerous metals to animals) [15]. Phytoremediation relies on the use of plants that can absorb and accumulate metals from the soil or water. The effectiveness of phytoremediation is influenced by both the ability of plants to store and absorb metals as well as their availability to the plants. Rhizofiltration is a sort of phytoremediation in which

To cite this article: Tariq M, MM Sharif, M Naeem, I Tahir & S Qasim. 2024. Metals toxicity in cattle: focusing on effective management strategies. Biological Times, 3(2): 1-2.

excess nutrients or toxins are removed from surface water, wastewater, and polluted groundwater through a complex root system (Kristantiet al., 2021). The procedure involves both absorption and adsorption of the contaminants on the root. To remove heavy metals from the environment, rhizofiltration is utilized.

Conclusion

It is concluded that lead and cadmium have high toxicity in the kidney and thus leads to acute kidney disorders in cattle however arsenic also accumulate in kidney but in low intensity. Advanced technologies can reduce occupational exposure to heavy metals. Monitoring exposure and perhaps intervening to reduce subsequent exposure to heavy metals in the animals and environment can be a significant step toward prevention. Failure to reduce the exposure will lead to serious issues in the future due to the negative effects of heavy metals.

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