UNIVERSITY OF LIFE SCIENCES ”KING MIHAI I” FROM TIMISOARA
”YOUNG PEOPLE AND MULTIDISCIPLINARY RESEARCH IN APPLIED LIFE SCIENCES”

05-06 November 2026



Plant-Derived Compounds Against Metal-Induced Oxidative Stress in Veterinary Species

Harieta Natalia Muntean[1], Maria-Larisa Rusu[1], Mihai Folescu[1], Alexandru Octavian Doma[1], Romeo Teodor Cristina[1], Eugenia Dumitrescu[1], Florin Muselin[1]

[1] University of Life Sciences “King Mihai I” from Timișoara, Romania

Abstract: Exposure to potentially toxic metals can disturb antioxidant defences and compromise animal health and productivity. Plant-derived compounds have been investigated as supportive interventions, but their effects depend on the toxicant, preparation and animal model. This narrative review discusses selected experimental evidence on cadmium and lead exposure, with emphasis on poultry and relevant rodent models. In chickens, luteolin and rutin preparations have been associated with improvements in selected markers of oxidative damage and tissue health. Rodent experiments provide complementary evidence for reduced cadmium accumulation following *Aronia melanocarpa* polyphenols and for Nrf2-associated protection by proanthocyanidins during lead exposure. Proposed mechanisms include modification of metal uptake and regulation of endogenous antioxidant responses; these mechanisms cannot be assumed to operate equally in every species or preparation. Heterogeneity in dose, exposure route, outcome measures and bioavailability restricts comparisons and clinical translation. Controlled studies in target veterinary species should assess tissue residues, safety, animal health and production outcomes alongside biochemical markers. Preventing exposure remains the primary intervention. Plant-derived products are research candidates rather than established treatments for metal intoxication.

Introduction

Contamination of feed, water and soil can expose animals to potentially toxic elements. Cadmium and lead are of particular concern because exposure can affect multiple organs and disturb antioxidant systems. Oxidative stress may arise when oxidant production and protective defences become unbalanced; measurements such as malondialdehyde (MDA), reduced glutathione and antioxidant enzyme activity are useful indicators but do not by themselves establish clinical disease . In poultry, the relevance of these markers therefore depends on the exposure context, the tissues examined and whether changes in oxidative indices are accompanied by functional or productive impairment, such as altered liver or intestinal histology and biochemistry .

Unlike iron and copper, cadmium and lead do not undergo Fenton redox cycling under physiological conditions. Their indirect effects include interactions with thiol groups and disturbances in antioxidant and metal homeostasis. The term “heavy metals” is common in toxicology, but this review names individual elements because their chemistry and toxicokinetics differ . Accordingly, the evidence reviewed here is discussed element by element, since the biological effects of cadmium and lead cannot be reliably generalised from one metal to another, and the kidney is a particularly sensitive target for cadmium and lead toxicity in cattle . Clinical signs in cattle exposed to these metals are often nonspecific, and renal damage may be detected only after tubular injury has progressed, which makes early diagnosis and the interpretation of oxidative biomarkers in this species especially challenging

Material and method

This is a focused narrative review based on selected publications in the supplied draft and verification of key primary studies through PubMed and accessible publisher records. It prioritises studies in which an identified plant-derived preparation was administered during experimental cadmium or lead exposure, including poultry and rodent models. Rodent models are included for mechanistic context and are identified separately from veterinary species. This is not a systematic review: a reproducible search strategy, study selection flow and formal risk-of-bias assessment were not undertaken. Narrative reviews can provide a selective synthesis and interpretation of a body of literature, but their scope and selection process should be made clear. The examples are illustrative rather than an exhaustive inventory, and study results were not pooled. Consequently, the synthesis presented below should be read as an orientation to the experimental literature rather than as a quantitative estimate of effect size or a basis for dosing recommendations in livestock.

Plant preparations can contain diverse polyphenols and other bioactive molecules, but chemical antioxidant activity measured in vitro does not establish efficacy at concentrations achievable in animal tissues. Polyphenols have been shown to exert antioxidative and anti-inflammatory effects in cell culture, rodent and human studies, whereas these effects have been less investigated in farm animals , and the benefits that are observed depend strongly on the animal species and its physiological state, the plant source and the type and dose of polyphenols applied . Potential mechanisms therefore include effects on absorption, interactions with metal ions, inflammatory signalling and the regulation of endogenous antioxidant responses. Extract composition, formulation and metabolism affect which compounds reach tissues, and because most of this work is conducted in rodents, the translation of these pharmacokinetic and mechanistic observations to poultry and ruminants remains uncertain. Flavonoid supplementation has also been examined as a way of modifying the distribution of trace elements themselves. In mice with diet-induced dyslipidemia, quercetin was followed by higher blood concentrations of silver, barium, chromium, iron, nickel and zinc , and the most perceptible change was a significant decrease in the toxic trace elements cadmium and lead in blood and organs . Because this model did not involve controlled metal exposure, the observation suggests a redistribution effect rather than protection against cadmium or lead intoxication.

Results and discussions

Study / model	Metal / intervention	Main observation	Limitation
Zou et al., 2024 Chickens	Cd / luteolin	Improved liver, intestinal and oxidative-stress outcomes.	Single model; no field validation.
Wahed et al., 2023 Broilers	Pb / rutin or rutin nanoparticles	Growth, economic, oxidative and tissue outcomes compared.	Exposure- and formulation-specific.
Brzóska et al., 2015 Rats	Cd / *Aronia melanocarpa* polyphenols	Lower apparent absorption and tissue accumulation, mainly at the higher exposure.	Rodent model.
Long et al., 2016 Mice	Pb / proanthocyanidins	Less hepatic oxidative damage; Nrf2/ARE-associated changes.	Mechanistic rodent evidence.
Gutyj et al., 2022 Rats	Pb + Cd / Butaselmevit-Plus	Increased antioxidant enzyme activity.	Mixed supplement; botanical contribution uncertain.
Ostapyuk et al., 2025 Laying hens	Cd / *Silybum marianum*	Lower lipid peroxidation; higher glutathione and antioxidant enzyme activity.	Small sample; single preparation.
Slobodian et al., 2021 Young bulls	Pb + Cd / Metisevit Plus	Improved glutathione system, catalase and superoxide dismutase activity.	Mixed supplement; small sample.
Muselin et al., 2022 Mice	Background Cd + Pb / quercetin	Lower blood and organ Cd and Pb.	No controlled metal exposure; associations only.

Conclusions

Selected studies suggest that luteolin, rutin, *Aronia* polyphenols and proanthocyanidins may attenuate particular effects of experimental cadmium or lead exposure. Evidence is formulation- and model-specific, and rodent findings cannot be assumed to apply directly to veterinary species. Species-specific dose-response and field studies linking tissue metal burden to health, production and safety outcomes are required before these compounds can be recommended as supportive interventions.