



Bioactive organic and inorganic compounds in Latin American foods and plants: A review

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ABSTRACT

Latin America contains some of the world's most diverse agroecosystems and food crops, ranging from major staples such as maize and potato to bioactive-rich matrices such as quinoa, amaranth, chia, cacao, acai, and yerba mate. These foods contain organic compounds, including phenolics, carotenoids, tocopherols, saponins, alkaloids, and protein-derived peptides, together with inorganic elements that may be nutritionally essential or toxic depending on concentration, chemical form, and exposure context. Previous reviews have often treated nutritional bioactivity and toxicological contamination as separate topics. This critical review instead evaluates them through an integrated benefit-risk framework that considers crop genetics, ecosystem variation, processing, bioaccessibility, analytical comparability, and dietary exposure. The synthesis shows that many reported antioxidant, anti-inflammatory, cardiometabolic, and neuroprotective effects remain strongest at the in vitro or animal-model level, whereas human dose-response evidence is limited and often confounded by matrix complexity. Conversely, toxicological evidence for arsenic, cadmium, lead, mercury, pesticide residues, and emerging contaminants is increasingly supported by environmental monitoring and risk-modeling studies, although biomonitoring and longitudinal dietary-exposure data remain scarce. The review identifies four major gaps: limited data on interactions between nutrients, antinutrients, and contaminants; insufficient harmonization of LC-MS/MS, HRMS, ICP-MS/ICP-OES, and NMR-based workflows; weak conversion of compositional data into realistic intake and exposure estimates; and underuse of cultivar-, landrace-, and ecosystem-specific comparisons. A coordinated research agenda combining original analytical studies, exposure modeling, controlled human studies, and equitable integration of Indigenous knowledge is needed to transform Latin American biodiversity into safe, evidence-based nutritional and functional-food innovation.

1. Introduction

Latin America is a major center of biological, cultural, and agro-ecological diversity, with food systems shaped by Indigenous knowledge, regional ecosystems, and long-standing crop domestication. The region includes globally important staple crops such as maize (*Zea mays* L.) and potato (*Solanum tuberosum* L.), which contribute substantially to dietary energy, food security, and local livelihoods. Alongside these staples, Latin America also contains nutritionally distinctive pseudocereals, fruits, seeds, and beverages, including quinoa, amaranth, chia, cacao, acai, and yerba mate (Ebel et al., 2024; Lamino Jaramillo & Boren-Alpizar, 2023; De la Parra-Guerra et al., 2026). This distinction is important because production prominence and bioactive-compound density are not necessarily equivalent: maize and potato are central to caloric intake and regional food systems, whereas quinoa, amaranth,

chia, cacao, acai, and yerba mate are frequently emphasized for their rich profiles of phenolic compounds, peptides, tocopherols, phytosterols, methylxanthines, essential minerals, and antinutritional factors (Davi et al., 2023; Guo et al., 2025; Hernandez-Perez & Paredes-Lopez, 2025; Kussmann et al., 2023; Ruskovska et al., 2023).

Traditional crops such as quinoa, amaranth, and other Andean species have long been valued by Indigenous communities for their nutritional quality, resilience under marginal growing conditions, and therapeutic relevance. Contemporary studies increasingly support these traditional uses by showing that these crops contain high-quality proteins, bioactive peptides, phenolics, tocopherols, phytosterols, and minerals associated with antioxidant, metabolic, and cardioprotective functions (Davi et al., 2023; Guo et al., 2025). Similarly, amaranth, chia, and quinoa have been identified as prominent plant species cultivated in Latin American soils because of their adaptability, nutritional value, and

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