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## How to cite and abstracts

1. Frédéric Bonté, The duality of Ferroptosis: a new illustration of the Janus god, *Revista Boliviana de Química*, 2026, Vol 43, N°1, 1-5. DOI <https://doi.org/10.53287/pyii9560fa26n>

### Abstract

Ferroptosis, a regulated form of cell death driven by iron-dependent lipid peroxidation, has emerged as a critical mechanism in diverse biological contexts. Its involvement spans human diseases, aging processes, and plant immunity, positioning ferroptosis as both a challenge and an opportunity for therapeutic innovation. Plant-derived molecules represent a promising source of modulators capable of either inducing or inhibiting ferroptosis, while current research emphasizes the synthesis of small molecules, optimization of administration routes, and evaluation of localized activity in specific pathologies.

Beyond disease treatment, ferroptosis is increasingly recognized as central to the concept of healthy aging. The progressive decline in resistance to oxidative stress—exacerbated by environmental pollution and modern lifestyles—disrupts cellular redox balance, leading to metabolic and dermatological disorders. Strategies aimed at inhibiting ferroptosis hold potential to mitigate age-related damage, preserve tissue integrity, and promote longevity.

Ultimately, ferroptosis underscores the essential yet often overlooked role of iron in maintaining cellular homeostasis, highlighting its importance in both biomedical research and translational applications.

2. Rafael J. Tornero Jimenez\*, Sulema Nieves Valdez Castro, Rigoberto R. Choque Aspiazu, Osmar V. Tarquino Hurtado, Estandarización del método de determinación de fosfatos en aguas de río Katari por espectrofotometría ultravioleta-visible, *Revista Boliviana de Química*, 2026, Vol. 43, N°1, 6-13. DOI <https://doi.org/10.53287/pyii9560fa46q>

#### Abstract

*Standardization of the method for determining phosphates in Katari river waters by ultraviolet-visible spectrophotometry.* This article presents a standardization of the phosphate determination method using ultraviolet-visible spectrophotometry, a key technique for water quality assessment. The measurement of phosphates provides relevant information about the condition and usage of the waters flowing into the river, offering insights into contamination levels and water management practices. The proposed method allows for the detection of phosphate concentrations in the range of 0.5 to 1.5 mg PO<sub>4</sub><sup>3-</sup>/L, thus contributing to more precise and efficient monitoring of aquatic ecosystems.

3. German Quille-Calizaya, Teófilo Donaires-Flores, Oswaldo Luzver Maynas-Condori, Sergio Tito Arohuanca-Mamani, Moisés Pérez Capa, Heber Nehemias Chui-Betancur, Caracterización y concentración de óxido de litio por proceso de flotación a partir de mineral del yacimiento Macusani, Puno-Perú, *Revista Boliviana de Química*, 2026, Vol 43, N°1, 14-25. DOI <https://doi.org/10.53287/pyii9560fa26r>

#### Abstract

The study assessed the feasibility of producing lithium oxide concentrate from volcanic tuffs at the Macusani deposit (Puno, Peru). Lithium occurs in aluminosilicates and potassium silicates associated with uranium, complicating direct extraction. X-ray diffraction revealed silicon oxide (46%), aluminum-sodium silicate (32.11%), aluminum-potassium silicate (18.59%), and a complex lithium-bearing compound (3.30%). The initial grade was 2219 ppm Li, which increased to 3217 ppm (0.68% Li<sub>2</sub>O) through reverse flotation, achieving 84.67% recovery. Optimal flotation conditions were pH 3, with sodium oleate (NaOL) and Aeromine 3030C dosages of 40 g/t and 56 g/t, respectively. Nevertheless, the method proved limited in effectively separating gangue.

4. Lilian Sarahy Pecina Perez, Regulo Ruiz Salazar, Guadalupe Rodriguez Castillejos, José Luis Hernández Mendoza, Cristián Lizarazo Ortega, Jesús Di Carlo Quiroz Velásquez, Revisión bibliográfica sobre los hongos micorrízicos arbusculares: su diversidad, funciones y aplicaciones en la agricultura sostenible, *Revista Boliviana de Química*, 2026, Vol 43, N°1, 26-31. DOI <https://doi.org/10.53287/pyii9560fa94c>

#### Abstract

Arbuscular mycorrhizal fungi (AMF) establish symbiotic relationships with most vascular plants, boosting nutrient and water absorption, strengthening tolerance to

biotic and abiotic stresses, and supporting agricultural and environmental sustainability. This review synthesizes recent findings on AMF diversity, ecology, and practical applications across varied agroecosystems, including key crops such as cinchona, sorghum, banana, cocoa, guava, onion, and lettuce. Their contributions to plant protection, soil enhancement, genomic progress, and prospects in biotechnology and phytoremediation are examined. Evidence highlights that native AMF consortia, adapted to local environments, are pivotal for sustainable agriculture, reducing reliance on chemical inputs and increasing the resilience of production systems.

5. Ricardo Reyes Hernández, Horacio Martínez Valencia, David Juárez Romero, Víctor Zezatti Flores, Oscar Sotelo Mazon, Arianna Parrales Bahena, Angel Tlatelpa Becerro, Análisis cuantitativo de un acero austénico forjado y nitrurado por plasma, *Revista Boliviana de Química*, 2026, Vol 43, N°1, 32-42. DOI <https://doi.org/10.53287/pyii9560fa09k>

#### Abstract

*Quantitative analysis of an austenitic steel forged and plasma nitrided.* We developed a 18Cr-18Mn steel intended for retaining rings in electric generators. In its austenitic phase, predicted using the Schaeffler diagram, a Nieq>30 corresponds to an austenitic steel for a Creq of 20.7; however, once forged and nitrided, it acquires duplex traits, exhibiting high corrosion resistance and immunity to stress corrosion. In addition, we present a study and discussion on nitrogen concentration together with analytical results of the steel's crystalline structure, its phases, and the corrosion tests performed.

6. Valerio Choque Flores, Ángel Maldonado, Rigoberto Choque, Rómulo Gemio Siñani, Ariana Zeballos Espinoza, Mario Blanco Cazas, Adsorción de fósforo en suelos de cultivo en Beni y La Paz, *Revista Boliviana de Química*, 2026, Vol 43, N°1, 43-52. DOI <https://doi.org/10.53287/pyii9560fa64t>

#### Abstract

*Phosphorus adsorption in cultivated soils in Beni and La Paz.* In this work, the adsorption of phosphorus from solution in cultivated soils to Beni and La Paz department was studied using different adsorption isotherm models. The cultivated soils were characterized by soil texture, percentage of organic matter and organic carbon, and pH. The phases present were identified by X-ray diffraction. The results of phosphorus adsorption obey a type L model, according to the Giles classification; whose results after linear regression, are assimilated to a Langmuir type behavior with maximum adsorption capacities of the samples (M4), (MC), (MG) and (MN) of 0.0768, 11.06, 1.228, and 22.88 mg P/g soil respectively

7. Alejandro Sánchez Varela, Isabel Cristina Rodríguez Luna, Aplicaciones e implicaciones biotecnológicas de *Agrobacterium tumefaciens*, *Revista Boliviana de Química*, 2026, Vol 43, N°1, 53-57. DOI <https://doi.org/10.53287/pyii9560fa23f>

#### Abstract

*Biotechnological applications and implications of Agrobacterium tumefaciens.* *Agrobacterium tumefaciens* is a widespread bacterium recognized for inducing plant diseases, most notably crown gall or tumor formation. This pathogen can severely diminish crop yields, thereby reducing agricultural productivity and generating economic losses for farmers. Its presence in infected plants also disrupts local ecosystems, creating imbalances in both flora and fauna. The damage extends beyond cultivated species, as other organisms within the ecosystem may be affected. Effective management of this infection is therefore crucial to safeguard crop health and ecological stability, requiring continuous monitoring and the implementation of strategies to mitigate its impact. Interestingly, despite its pathogenic role, *A. tumefaciens* has become a valuable biotechnological tool due to its natural ability to transfer genetic material across species. This property enables the introduction of genes that enhance crop resistance to pests, stimulate metabolite production, or even support applications in human gene therapy, highlighting its dual significance in agriculture and biotechnology.

8. Nandy Sharlin Reyes Patton<sup>1</sup>, Rocío Griselda Choque<sup>2</sup>, Luis Fernando Cáceres Choque, Desarrollo y Aplicación del Sistema de Dosimetría Fricke para el Estudio de la Distribución por Mapeo de Dosis en un Irradiador Industrial Gamma ( $\gamma$ ), *Revista Boliviana de Química*, 2026, Vol 43, N°1, 58-69. DOI <https://doi.org/10.53287/pyii9560fa79p>

#### Abstract

*Development and Application of the Fricke Dosimetry System for the Study of Dose Distribution by Mapping in an Industrial Gamma ( $\gamma$ ) Irradiator.* The Fricke dosimetric system was implemented and evaluated with the aim of determining dose distribution in industrial gamma irradiators. The study comprised four experimental stages: initial system evaluation, batch irradiation, identification of the inflection point, and dose mapping in the irradiators. Results showed that the experimentally absorbed dose correlated well with theoretical values within the established operating range (20–400 Gy), with an inflection point identified at 450 Gy. Dose mapping revealed significant variations among different regions of the irradiator, highlighting the need to optimize its uniformity. In addition, irradiated dosimeters maintained chemical stability for at least one week under controlled conditions, supporting their applicability in the industrial sector. Overall, the findings confirm that the Fricke system is a reliable, economical, and valid technical alternative for dosimetric studies in gamma irradiators.

9. Rodney Mc Donald<sup>1</sup>, Ashish Kumar Tiwari<sup>2</sup>, Sharlene Roberts<sup>1</sup>, Brij Bhushan Tewari, Ferrate (VI) technology in water and wastewater treatment, *Revista Boliviana de Química*, 2026, Vol 43, N°1, 70-90. DOI <https://doi.org/10.53287/pyii9560fa97n>

#### Abstract

This study explores the effectiveness of metal ferrates in treating water and wastewater from Demerara and Berbice counties in Guyana. Conventional chlorination, though widely applied, poses limitations: it can generate carcinogenic by-products when

reacting with organic matter, and pathogens such as anthrax and *Cryptosporidium* remain resistant. Consequently, ferrates were investigated as an alternative disinfectant. Their multifunctional properties—oxidizing, coagulating, flocculating, and disinfecting—make them superior to traditional methods. Potassium, barium, cesium, and magnesium ferrates were synthesized and characterized using spectral techniques. Samples included tap water from Berbice, surface water from the University of Guyana pond, and wastewater from Banks DIH Ltd. and Bosai Mining Company. Key water quality indicators—turbidity, pH, alkalinity, hardness, chloride, iron, and color—were measured before and after treatment to assess performance. Among the synthesized ferrates, potassium ferrate demonstrated the highest treatment potential, while magnesium ferrate showed the lowest efficiency compared with other tested compounds..

10. Ktlyn Aguirre-De la Quintana, Marizol Flores, Amaury Seyse, Ludmila Pizarro, Mauricio Ormachea, Marc Pouilly, Eléonore Resongles, Lead levels in *Prochilodus lineatus* from the Pilcomayo River: comparison of historical and current data and implications for human health risk, *Revista Boliviana de Química*, 2026, Vol 43, N°1, 91-102. DOI <https://doi.org/10.53287/pyii9560fa54y>

#### Abstract

The Pilcomayo River has been historically affected by metal contamination associated with mining activities in the Andean headwaters, raising concerns about metal accumulation in fish and potential risks for human consumption. This study assessed current lead concentrations in muscle, liver, and opercular tissues of *Prochilodus lineatus* collected in 2024 in the middle basin of the Pilcomayo River (Villa Montes, Bolivia), and compared them with historical data to depict trends in Pb contamination. Lead levels differed significantly among tissues, with the highest concentrations in operculum ( $0.799 \pm 0.535$  mg kg<sup>-1</sup> ww), followed by liver ( $0.099 \pm 0.111$  mg kg<sup>-1</sup> ww), and muscle ( $0.013 \pm 0.012$  mg kg<sup>-1</sup> ww). Human exposure, evaluated through estimated daily intake (EDI), ranged from  $8.67 \times 10^{-7}$  to  $4.26 \times 10^{-5}$  mg kg<sup>-1</sup> day<sup>-1</sup> depending on the population group and consumption scenario, and are below exposure levels associated with adverse health effects reported by World Health Organization.

11. Bonifacio Alejo Ticona\*, Edson Mamani Alvarado, Pruebas de cianuración de oro de colas relaves procedentes de cooperativas mineras del norte/noreste de La Paz, sector Illimani, *Revista Boliviana de Química*, 2026, Vol 43, N°1, 103-114. DOI <https://doi.org/10.53287/pyii9560fa26j>

#### Abstract

*Gold cyanidation tests of tailings from cooperatives* In this study, cyanidation tests of gold in alkaline medium were carried out using tailings from three mining cooperatives. The Aucapata sample showed a high head grade (12.49 g/t), with free particles ranging from 5–50 µm and occasionally up to 100 µm. However, cyanide-consuming minerals were present: pyrite (5%), chalcopyrite (1%), magnetite (3%), and iron hydroxide (4%). Under 24 h leaching and P80 of 241.16 µm, recovery reached

70.08%, increasing to over 94% after regrinding to P80 of 74  $\mu\text{m}$ . In San Pablo, coarse tailings (P80 = 478.83  $\mu\text{m}$ ) yielded 76.82% recovery in 24 h. In contrast, San Bartolomé, with finer particles (P80 = 158.57  $\mu\text{m}$ ), achieved 80.38% in the same period. These findings highlight that, given the predominance of fine gold particles, cyanide leaching is the most suitable method for materials with such characteristics.

12. Jenry H. Sirpa-Poma\*, G. L. Cruz-Ochoa, Heide Geovana Quispe Quelca, Juan Antonio Alvarado Kirígin, Validación del método DPPH, 2,2-diphenyl-1-picrylhydrazyl, en la determinación de la capacidad antioxidante total en granos de cacao y chocolate artesanal de Bolivia, *Revista Boliviana de Química*, 2026, Vol 43, N°1, 115-127. DOI <https://doi.org/10.53287/pyii9560fa91w>

#### Abstract

*Validation of the DPPH, 2,2-diphenyl-1-picrylhydrazyl method for the determination of the total antioxidant capacity in cocoa beans and artisanal chocolate from Bolivia.* This study focuses on validating the **DPPH method** (2,2-diphenyl-1-picrylhydrazyl) for assessing total antioxidant capacity in Bolivian cocoa beans and artisanal chocolate. Among available techniques, the DPPH assay is widely applied, and its validation ensures reliability of the results. The research aimed to confirm its suitability for determining antioxidant potential in these matrices. Trolox was employed as a reference standard to evaluate free radical inhibition. Eight performance parameters were analyzed according to ISO guidelines: precision (repeatability and intermediate precision), accuracy, detection limit, quantification limit, working range, linearity, robustness, and measurement uncertainty. To quantify antioxidant capacity, cocoa bean samples were extracted with bidistilled ethanol, and the supernatant was tested for its inhibitory effect on the DPPH radical. Results were expressed as milligrams of Trolox equivalents per gram of sample, providing a standardized measure of antioxidant activity in both cocoa and artisanal chocolate.

13. Romel Emil Aruquipa Buitre<sup>1,\*</sup>, Leonardo Guzmán Alegria<sup>1</sup>, Eleonore Resongles<sup>2</sup>, Israel Quino Lima<sup>1</sup> and Oswaldo Eduardo Ramos Ramos, Distribución geoquímica y disponibilidad de elementos esenciales y tóxicos en suelos agrícolas de Colquencha en el altiplano boliviano, *Revista Boliviana de Química*, 2026, Vol 43, N°1, 128-141. DOI <https://doi.org/10.53287/pyii9560fa84g>

*Geochemical distribution and availability of essential and toxic elements in agricultural soils of colquencha in the Bolivian highlands.* The geochemical distribution and availability of essential elements such as iron (Fe), manganese (Mn), copper (Cu), zinc (Zn), and potentially toxic elements including arsenic (As), cadmium (Cd), and lead (Pb) were evaluated in agricultural soils from Colquencha, La Paz. A sequential extraction procedure following the Community Bureau of Reference (BCR) method was applied to soil samples collected to a depth of 174 cm. The method's efficiency was validated by comparing the sum of the exchangeable (F1), reducible (F2), oxidizable (F3), and residual (FR) fractions with a Pseudo-Total Analysis (PTA) performed using acid digestion with nitric acid (HNO<sub>3</sub>) and hydrochloric acid (HCl), yielding a recovery rate of 91–103%. The distribution and mobility of the elements

were influenced by geochemical and geospatial factors, as well as by the physicochemical properties of the soil. The predominant fractions for each element were as follows: Mn: FR > F2 > F1 > F3; Fe: FR > F2 > F3 > F1; Cu: FR > F2 > F3 ≈ F1; Zn: FR > F2 > F1 > F3; As: FR > F2 > F3 > F1; Cd: FR > F2 > F1 > F3; Pb: FR > F2 > F3 > F1. The main mobilization factors were identified as Mn in surface layers, Cu at intermediate depths, and Cd at greater depths

14. Carolina Triguero, Maribel Lozano, Yonny R. Flores, Eduardo Gonzales, Silvia Zambrana and Giovanna R. Almanza, *Revista Boliviana de Química*, 2026, Vol 43, N°1, 142-160. DOI <https://doi.org/10.53287/pyii9560fa11e>

Quinoa processing residues, including mojuelo, are promising sources of bioactive compounds. This study designed a fractionation strategy to obtain saponin-enriched extracts through liquid–liquid partitioning and chromatographic separation, followed by LC–ESI–MS in positive ion mode. The hydroalcoholic extract contained 49.6% saponins and 19.7% phenolics. Mass spectrometry identified oleanane-type saponins and phenolic compounds. A major bidesmosidic saponin [3-O-β-D-glucopyranosyl-(1→3)-α-L-arabinopyranosyl-phytolaccagenic acid 28-O-β-D-glucopyranosyl] and the flavonoid mauritianin were isolated and used as standards. Fractionation raised saponin purity above 94%, while phenolics remained in crude extracts, which showed the strongest antioxidant activity in ABTS and DPPH assays. In vitro tests with LPS-stimulated RAW 264.7 macrophages revealed that saponin-rich fractions suppressed nitric oxide, TNF-α, and IL-6, and reduced PGE<sub>2</sub> and LTC<sub>4</sub>, suggesting modulation of COX-2 and 5-LOX pathways. These findings support quinoa residues as valuable nutraceutical resources.

15. Luís C., Resio, Extreme models of substances: a didactic proposal, *Revista Boliviana de Química*, 2026, Vol 43, N°1, 161-172. DOI <https://doi.org/10.53287/pyii9560fa20p>

#### Abstract

It is frequent to encounter concepts designated in an imprecise or misleading manner. A representative case is that of weight and mass, where both expressions are often applied interchangeably in classrooms without recognizing that the former pertains to the domain of vector magnitudes, while the latter belongs to the domain of scalars. A comparable situation arises with the notion of electromotive force, which does not involve any actual force, but instead denotes an electric potential. Taking these examples as reference, this study examines the concept of extreme models of substances. The difficulty identified lies in the insufficient differentiation between molecular substance and ionic substance, both at the strictly conceptual level and in the computational dimension. Such confusion is observed not only in teaching practice but also in textbooks and scientific articles. Ultimately, a methodology is proposed for the instruction of extreme models of substances, aiming to establish a precise conceptual distinction between each category of substance and to perform calculations that properly reflect the extreme models analyzed.