

Title	Aluminum accumulation and its relationship with mineral plant nutrients in 12 pteridophytes from Venezuela
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Abstract	<p>The purpose of this study was to investigate the aluminum (Al) concentration in <i>Lycopodium clavatum</i>, <i>Dicranopteris flexuosa</i>, <i>Sticherus nudus</i>, <i>Anemia villosa</i>, <i>Cyathea gibbosa</i>, <i>Pteridium arachnoideum</i>, <i>Pteris vittata</i>, <i>Thelypteris dentata</i>, <i>Blechnum occidentale</i>, <i>Elaphoglossum sporadolepis</i>, <i>Nephrolepis cordifolia</i> and <i>Polypodium pseudoaureum</i>, species from 11 families with different phylogenetic position, found on soils with a high concentration of Al (up to 13 g kg⁻¹ dry mass (DM)). When Al concentration and mineral nutrients in aerial organs were considered, pteridophytes were classified into three groups: group one included pteridophytes with Al concentrations over 1000 mg kg⁻¹ DM in their aerial organs, a ratio between Al and essential plant nutrients such as Ca, Mg and P higher than one and a K/Al ratio between 0.68 and 2.56 mol mol⁻¹. In group 1 was the well known Al-accumulator <i>L. clavatum</i> (Lycophyte) as well as the Neotropical ferns <i>D. flexuosa</i>, <i>S. nudus</i> (both basal leptosporangiate ferns), and <i>C. gibbosa</i> (core leptosporangiate tree fern). Group 2, ferns which accumulate Al over 1000 mg kg⁻¹ DM in their fronds, and had an Al/Ca and Al/Mg ratio <1. Species in this group included <i>E. sporadolepis</i> and <i>N. cordifolia</i> (derived polypod ferns). Group 3, ferns classified as Al-excluders, showing Al concentration <782 mg kg⁻¹ DM in the fronds, had Al/Ca and Al/Mg ratios <1, Al/P ratio =1 and a K/Al ratio between 18.10 and 80.36 mol mol⁻¹. In group 3, were <i>A. villosa</i> (basal leptosporangiate fern) and the derived polypod ferns <i>P. arachnoideum</i>, <i>P. vittata</i>, <i>T. dentata</i>, <i>B. occidentale</i> and <i>P. pseudoaureum</i>. The translocation factor of Al from subterranean to aerial organs was up to 4 in <i>S. nudus</i>, and subterranean organs from <i>E. sporadolepis</i> showed the highest concentration of Al (12 g kg⁻¹ DM). We coincide with early literature in that other criteria in addition to the Al concentration should be considered to define the Al accumulation, such as its relationship with macronutrients. For example, we propose the inclusion of K/Al ratio. We conclude that out of six Al-excluders five belonged to the derived polypods while two species from Polypodiales showed high Al concentrations. We reconfirm accumulation of Al in <i>L. clavatum</i> and <i>C. gibbosa</i> and discover two new Al-accumulating species in the more ancient ferns: <i>S. nudus</i> and <i>D. flexuosa</i>.</p>
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