

Innovative in vitro strategy for assessing aluminum bioavailability in oral care products

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INTRODUCTION

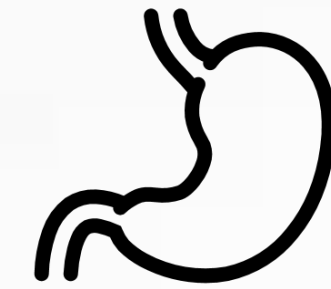
Aluminum is an ubiquitous element found in nature and in human-made products. It may trigger several adverse health effects in humans, interfering with the metabolism of other cations and inducing gastrointestinal upset and neurotoxicity. In cosmetics, aluminum is used in antiperspirants, lipsticks, and toothpastes. In the light of recent data, the Scientific Committee on Consumer Safety (SCCS) considers that the use of aluminum compounds is safe at the percentage of 2.65% in toothpastes. No data are available on aluminum leach, eventually ingested with toothpaste. In this study, the bioavailability of aluminum included in cosmetic products used for oral care was assessed.

MATERIALS AND METHODS

Accidental ingestion of aluminum in toothpastes was evaluated by in vitro digestion according to the INFOGEST model¹.



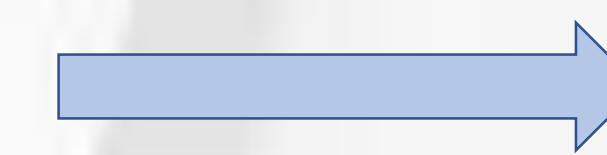
Oral phase: incubation of toothpaste with simulated salivary fluid for 2 min at 37°C and pH 7.0 under agitation.



Gastric phase: oral bolus was mixed with simulated gastric fluid for 2 h at 37°C and pH 3.0 under agitation.



Intestinal phase: gastric digesta was mixed with simulated intestinal fluid, for 2 h at 37°C and pH 7.0 under agitation.



The mixture of each phase was centrifuged to separate the insoluble Al(OH)₃ from Al³⁺ leached for ICP-AES analyses.



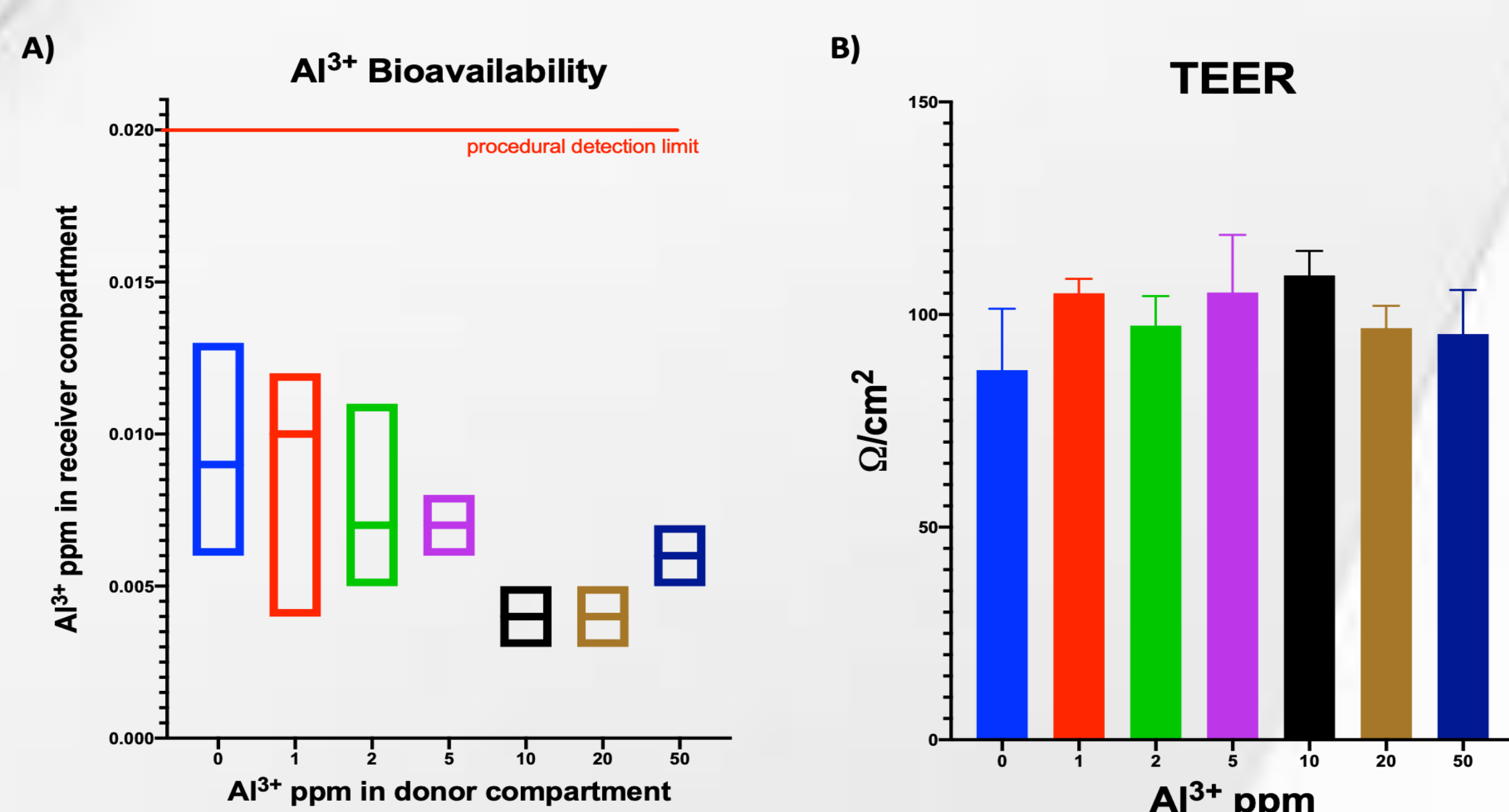
The bioavailability of accidentally ingested Al³⁺ was evaluated by incubating Al³⁺ solutions with EpilIntestinal 3D model (MatTek) for 2h, with concentrations: 1, 2, 5, 7, 10, 20, 50 ppm.

- Tissue architecture was analyzed under light microscope.
- The EpilIntestinal tissue barrier integrity was analyzed measuring transepithelial electric resistance (TEER).
- Margin of safety (MoS) was also calculated.

RESULTS

	Al ³⁺ starting amount (ppm)	Al ³⁺ leached (ppm)	Al ³⁺ leached (% with respect to starting amount)
Oral phase	131500	167±22.3	0.12%
Gastric phase	32900	17.7±7.2	0.05%
Intestinal phase	16500	3.4±3	0.02%

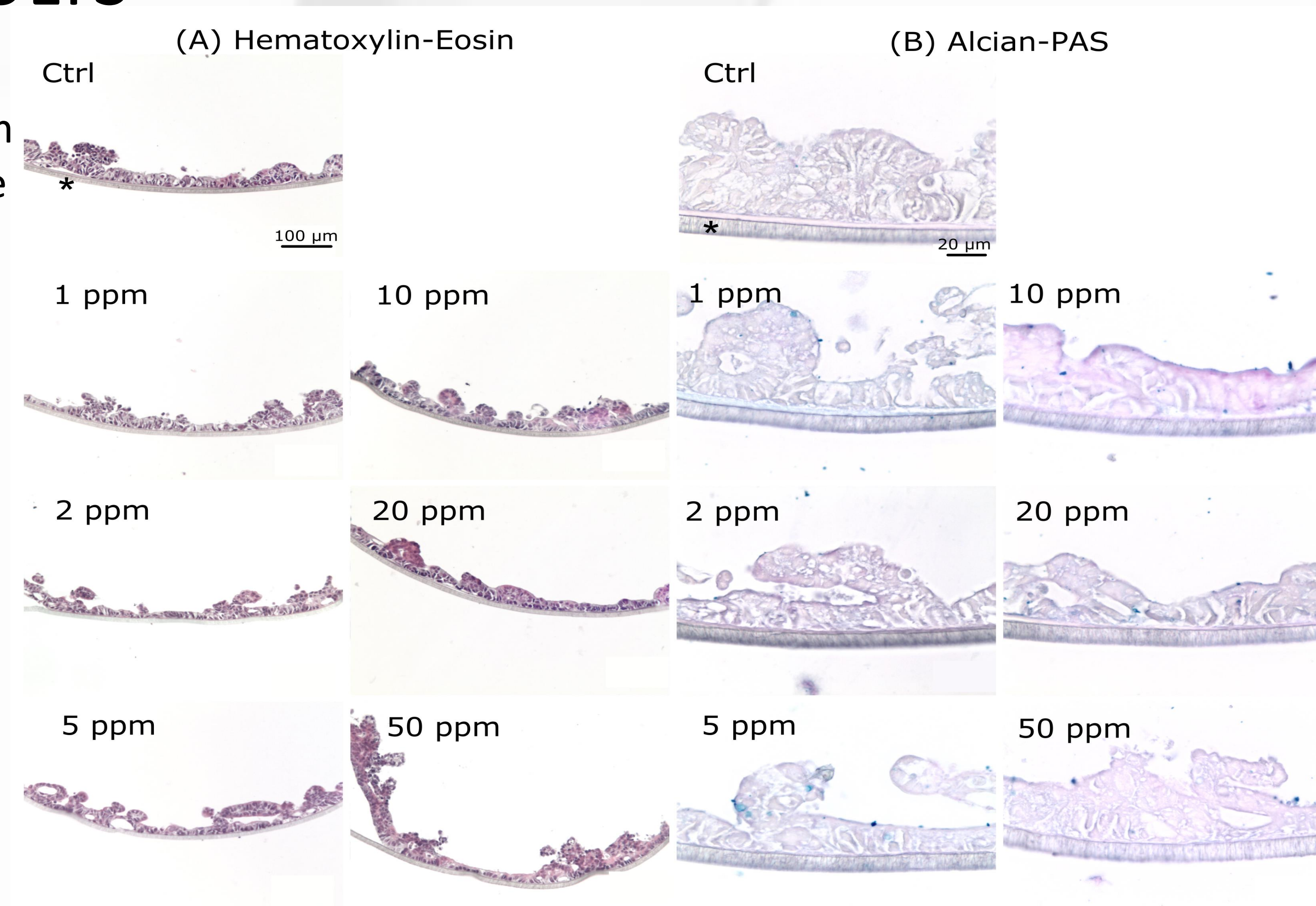
Assessment of aluminum leached from toothpaste during the passage through the digestive tract.



Assessment of Al³⁺ bioavailability corresponding to the passage throughout intestinal mucosa (A) and TEER measure (B).

CONCLUSION

The data presented are in line with thus demonstrating that the small amount of Al³⁺ able to trespass intestinal mucosa is safe. This is in line with SCCS opinion stating about safety of aluminum daily applications through cosmetic products.



(A) Hematoxylin-Eosin staining does not show visible alterations compared to the control after Al³⁺ exposure. (B) Alcian-PAS staining is quite weak and does not show any increase of mucopolysaccharide synthesis or accumulation compared to the control after Al³⁺ exposure.

REFERENCE

¹Brodkorb A, Recio I et al. INFOGEST static in vitro simulation of gastrointestinal food digestion. Nat Protoc. 2019 Apr;14(4):991-1014. doi: 10.1038/s41596-018-0119-1.