In vitro Gastric and Intestinal Bioaccessibility of Cesium from Ingested Contaminated Concrete Waste

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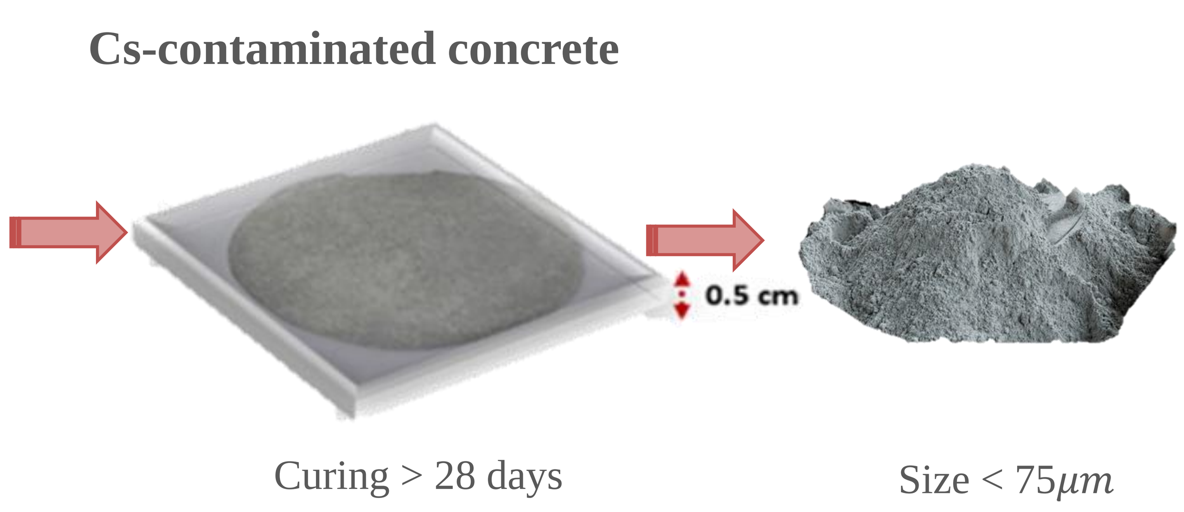
Introduction

- Cesium-137 (^{137}Cs) is a radioactive isotope produced by nuclear power plants, accidents, and weapons. Exposure through ingestion or inhalation can increase internal radiation dose and pose health risks.
- ^{137}Cs are absorbed through oral exposure or inhalation, distributed uniformly throughout the body, and compete with potassium (K) for membrane transport [1].
- This present study wants to assess the bioaccessibility (f_{ba}) of Cs in Cs-contaminated concrete (CC) using the Unified BARGE Method (UBM) by measuring the dissolved Cs from *in vitro* GI fluids.
- Herein, the contaminated concrete was spiked with 100 mg L^{-1} of stable Cs to simulate the contamination of Cs in concrete.
- Our research will improve our understanding of Cs exposure and ingestion risks, leading to better risk management for nuclear facility workers.

Materials and methods

Concrete preparation [2]

Materials	Weight
Sand	24.6 g
Fly ash	3.4 g
OPC (Type 1)	14 g
100 ppm of Cs solution	8 mL



UBM *in vitro* assay

- The bioaccessibility (f_{ba}) of Cs in CC was analyzed using the UBM [3] *in vitro* assay to mimic the human digestive processes.
- All GP and IP extractions were performed in triplicate for each soil sample. The Cs-f_{ba} was computed and expressed as follows:

$$f_{ba}(\%) = \frac{bioacccessible\ concentration\ of\ Cs\ (mg\ kg{-}1)}{total\ concentration\ of\ Cs\ in\ sample\ (mg\ kg{-}1)} \times 100$$

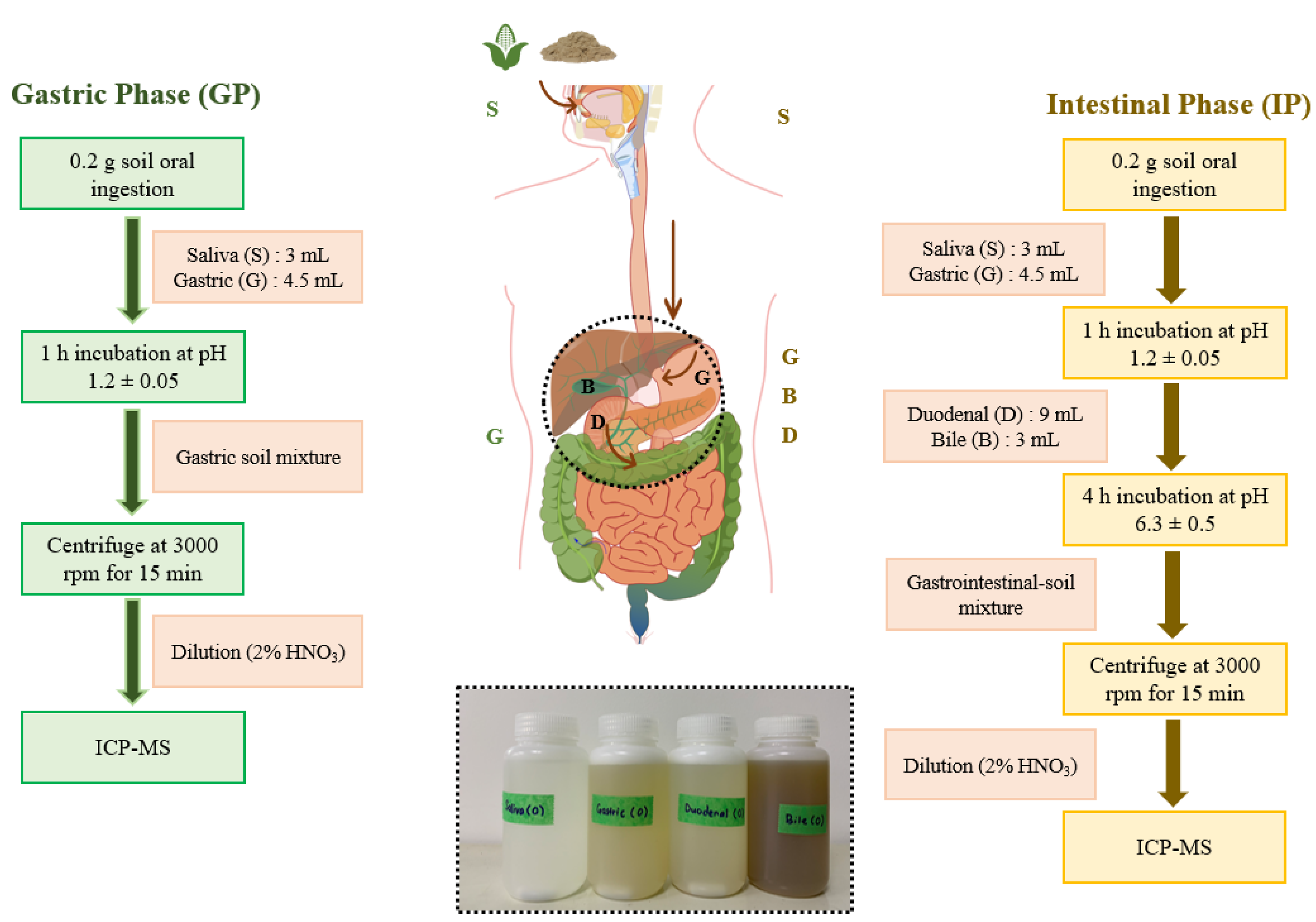


Fig. 1. Schematic diagram of UBM *in vitro* assays [3].

Results and discussions

Instrumental Neutron Activation Analysis (INAA)

Table 1. The total concentration of Cs using instrumental neutron activation analysis

Material	Concentration (mg kg^{-1})	Recovery (%)
Cs-CC	106.62 ± 1.40	84–124%

- The recovery percentage of Cs shows reasonable precision and is within acceptable range.

XRD, FESEM-EDS analysis

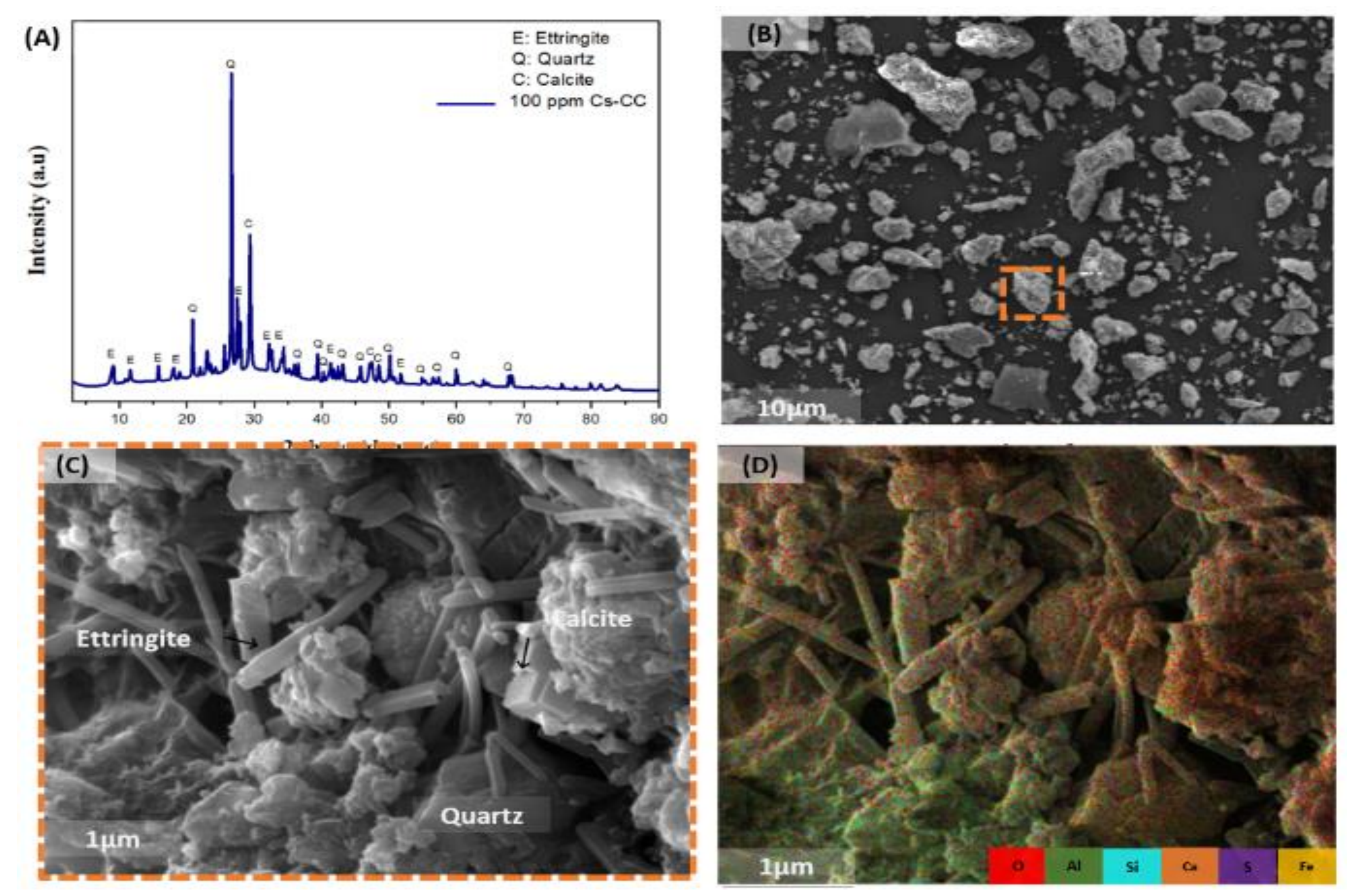


Fig. 2. Characterization shows intensity linked to quartz, ettringite, and calcite analysis using XRD (A) and FE-SEM-EDS images of Cs-contaminated concrete (B-D).

Assessment of Cs bioaccessibility

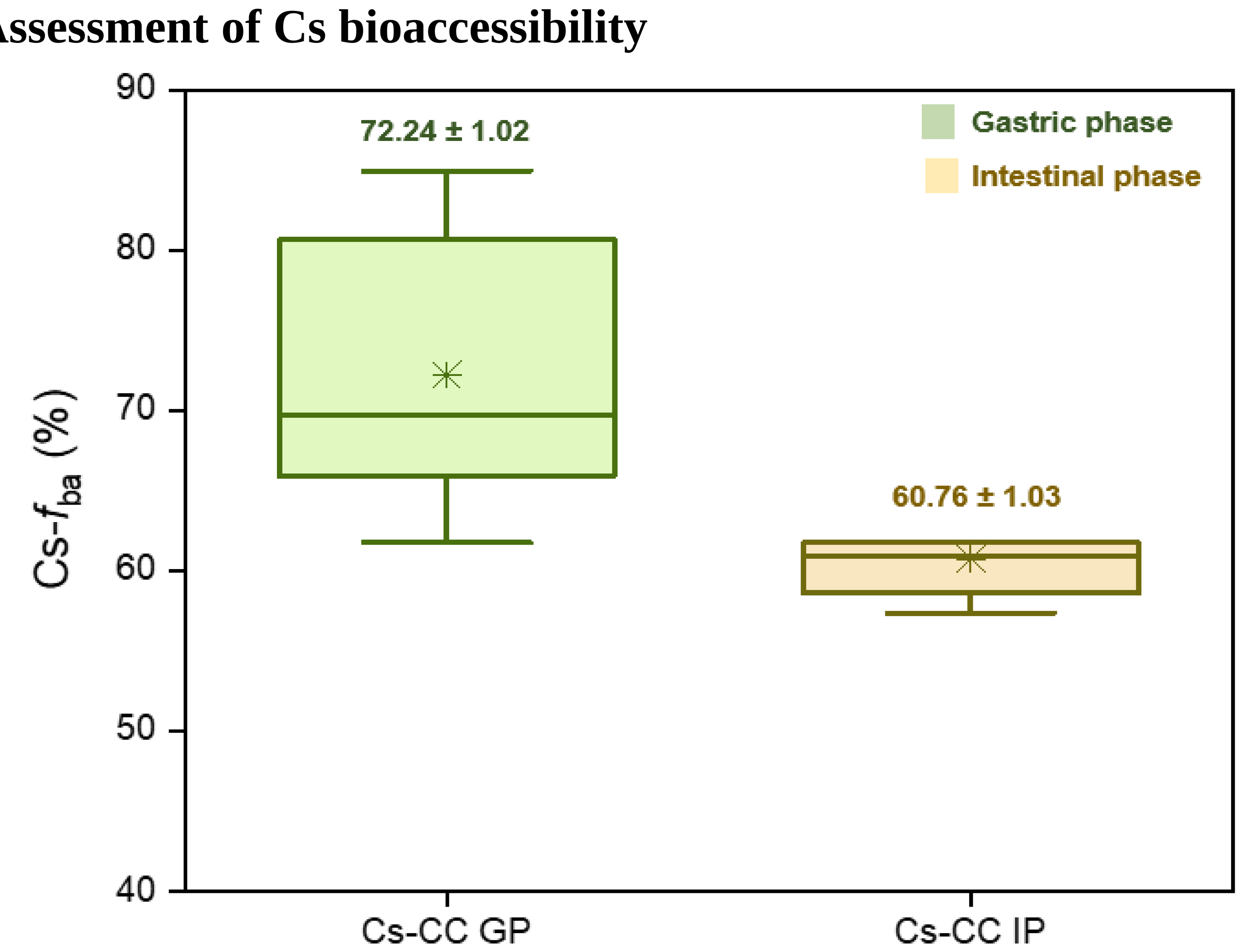


Fig. 3. The bioaccessibility of Cs in the GP and IP after oral exposure to Cs-CC.

- Cs-f_{ba} in GP (pH 1.2 ± 0.5) is higher than IP (pH 6.5 ± 0.5).
- Cs solubility behavior is influenced by pH conditions and the composition of contaminated concrete [4-5].

- The Cs-f_{ba} will increase during the GP period due to the acidic surroundings [4].
- The pH level in IP changes from acidic to more neutral, leading to a decrease in the solubility of Cs, which results in lower Cs-f_{ba}.
- When the pH level is high, certain phases in the concrete matrix can dissolve, causing the release of Cs^+ into the solution [5].

Conclusion

- The Cs- f_{ba} is higher in GP than IP following Cs-CC exposure suggesting that Cs is soluble in GP compared to IP.
- The pH and composition of contaminated concrete affect the bioaccessibility of Cs.

References

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Acknowledgments

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