In-Vitro Bioavailability of Metal Nutrients and Oxalic Acid in *Averrhoa bilimbi*

D. T. Raymond[1], A. M. Karunaratne[1] and R. Sivakanesan[2]

[1]*Department of Botany, Faculty of Science, University of Peradeniya*
[2]*Department of Biochemistry, Faculty of Medicine, University of Peradeniya*

Several acidic fruits found in Sri Lanka, utilised either as culinary or acidulants in human diets, are believed to increase bioavailability of certain mineral nutrients. However, the presence of inherent antinutritional components in addition to nutrition enhancers in acidic fruits may affect the bioavailability of nutrients. Diets may be monotonous, particularly in poverty stricken populations, and any physiological effects caused by antinutrients may exacerbate existing problems of malnutrition and chronic diseases such as urolithiasis associated with high levels of oxalate in the diet. For instance, the presence of phytic acid (PA) could inhibit bioavailability of metal nutrients while ascorbic acid (AA) could enhance bioavailability of minerals such as iron (Fe). There may be a mixture of metal nutrients, as well as antinutrients and nutrition enhancers in a composite meal. The current study was an investigation to determine the relative bioavailability of selected substances using a simulated gastrointestinal digestion system.

Before embarking on the main experiment, a preliminary experiment was carried out by selecting six popular acidic fruits, namely *Averrhoa bilimbi* (*Billing*), *Averrhoa carambola* (*Kamaranga*), *Citrus aurantifolia* (lime), *Garcinia quaesita* (*Goraka*), *Lycopersicon esculentum* (tomato), and *Tamarindus indica* (tamarind). They were analysed for acid (citric, malic, tartaric and oxalic) contents using a gravimetric precipitation technique. From the above findings *A. bilimbi* was chosen for the main experiment, which had an oxalic acid (OA) content of about 87%. Therefore, the objective of the present investigation was to analyse the relative influence of OA, PA and AA on *in vitro* bioavailability of three metal nutrients (Ca, Fe and Zn) and additionally, the bioavailability of OA in *A. bilimbi*.

Standard methods were used for analyses. The levels of Ca, Fe and Zn were analysed by atomic absorption spectrophotometry. The levels of OA were analysed by precipitating as calcium oxalate and reacting with indole reagent followed by colourimetry. The levels of PA were analysed by precipitating as ferric phytate and reacting with a chromogenic solution. The levels of AA were analysed by preparation of a test solution which was titrated with standard 2,6-dichlorophenol indophenol reagent. For the determination of bioavailability of Ca, Fe, Zn and OA *in vitro* gastrointestinal digestion was carried out by simulating oral, gastric and intestinal digestions using relevant enzymes and equilibrium dialysis where appropriate.

The bioavailabilities of the three metal nutrients were: Ca 4.2%, Fe 15.0% and Zn 26.2%. Linear regression analysis revealed that OA accounted for 83% (r^2 = 0.83) and 80% (r^2 = 0.80) inhibition of Ca and Zn absorption respectively. PA accounted for 66% (r^2 = 0.66) inhibition of Fe absorption. Furthermore AA accounted for 81% (r^2 = 0.81) and 76% (r^2 = 0.76) enhancement of Ca and Zn absorptions respectively. The OA bioavailability was 52.8%.

These findings infer that bioavailability of Ca, Fe and Zn are influenced by the acidic constituents present in *A. bilimbi*. The high bioavailability of OA in *A. bilimbi* is of concern due to its ability to cause urolithiasis.