Heavy metal exposure from cooked rice grain ingestion and its potential health risks to humans from total and bioavailable forms analysis

ABSTRACT

Heavy metal in rice studies has attracted a greater concern worldwide. However, there have been limited studies on marketed rice samples although it represents a vital ingestion portion for a real estimation of human health risk. This study was aimed to determine both total and bioaccessible of trace elements and heavy metals (Cd, Cr, Cu, Co, Al, Zn, As, Pb and Fe) in 22 varieties of cooked rice using an inductively coupled plasma-optical emission spectroscopy. Both total and bioaccessible of trace elements and heavy metals were digested using closed-nitric acid digestion and Rijksinstituut voor Volksgezondheid en Milieu (RIVM) *in vitro* digestion model, respectively. Human health risks via Health Risk Assessment (HRA) were conducted to understand exposure risks involving adults and children representing Malaysian population. Zinc was the highest while As was the lowest contents for total and in their bioavailable forms. Four clusters were identified: (1) Pb, As, Co, Cd and Cr; (2) Cu and Al; (3) Fe and (4) Zn. For HRA, there was no any risks found from single element exposure. While potential carcinogenic health risks present for both adult and children from single As exposure (Life time Cancer Risk, $LCR > 1 \times 10^{-4}$). Total Hazard Quotient values for adult and children were 27.0 and 18.0, respectively while total LCR values for adult and children were 0.0049 and 0.0032, respectively.

Keyword: Rice; Trace elements; Heavy metals; Total; Bioavailability; Accumulation; Health risks