Understanding the trace element landscape of Sri Lankan rice: Distribution and correlational patterns of toxic heavy metals and essential elements

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Sri Lankan rice is a potential source of nutritionally important essential elements (EEs) and undesirable co-contaminants which include heavy metals (HMs). EEs have an antagonistic response to HMs, by counteracting/detoxifying their effects. Therefore, a higher EE:HM ratio would have more nutritional value. This study investigated and compared cadmium (Cd), arsenic (As), lead (Pb), chromium (Cr) and EEs; zinc (Zn), selenium (Se), manganese (Mn), cobalt (Co) levels in 24 grain composites of commonly consumed rice (Traditional, Improved, Imported) varieties in Sri Lanka. Lyophilized grain powders were digested(*in-vitro*) and profiled using ICP-MS. The mean (±SD) and median (IQR) of the total HMs and total EEs were; 0.601±0.275, 0.702 (0.411) mg kg^{-1} and 46.545±9.136, 46.968 (13.158) mg kg^{-1}, respectively. The Total-HMs showed a weak positive correlation to Total-EEs (τ_b=0.101, p>0.05). The distribution of Cd showed positive correlations with all EEs, and with a statistically significant moderate correlation with Mn (τ_b=0.315, p<0.05). Pb positively correlated with all EEs (p>0.05). However, As positively correlated only with Zn (τ_b= 0.131, p>0.05) and correlated negatively with Se (τ_b= -0.136, p>0.05), Mn (τ_b= -0.116, p>0.05) and Co (τ_b= -0.004, p>0.05). Cr positively correlated with Zn (τ_b= 0.171, p>0.05) and Co (τ_b= 0.298, p<0.05) while negatively correlated with Se and Mn (p>0.05). The EE:HM ratio in the total rice sample ranged from 35.04 to 479.11. The median EE:HM ratio was higher in red pericarp grains compared to white and in parboiled rice than in non – parboiled rice (p>0.05). The EE:HM ratio Traditional rice was ~1.8 times that of both Improved or Imported rice (p>0.05). The median EE:HM ratios in Traditional rice decreased in the order *Kaluu-heenati> Pachchaperumal> Suwandel* while the ratios from Improved and Imported categories decreased in the order of; *Red-kekulu> White-Nadu> Red Nadu> Indian Basmati> Red and White Samba > White-Kekulu*. The results suggest that despite the overall positive correlation of total-EEs to total-HMs, strategic supplementation of some EEs; Se, Mn could reduce HM accumulation in rice grains. Inclusion of rice varieties with a high EE:HM ratio (i.e. Traditional) in daily dietary habits can help mitigating the exposure to HM by consumers.

Keywords: *Sri Lankan rice, Heavy metals, Essential elements, Toxic trace elements, Essential minerals*

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