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Extended Abstract

The Effect of Potassium Citrate and Tartrate as Chelating Agents on the Removal of Lead from Rice in the Cooking Process

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Abstract

Nowadays, the contamination of rice with heavy metals is one of the problems facing humanity. Therefore, the purpose of this study was to investigate the effect of soaking and cooking in the presence of chelating agents such as GRAS including, tartrate potassium and potassium citrate (200 mg/kg) on the removal of lead from three types of imported rice (India, Thailand and the United States). Atomic absorption measurements were performed in three replications and the difference in mean of 0.05 was done by Duncan test. The highest and lowest amount of lead was measured in Thai and Indian rice, 7337.33 and 380.63 μg/kg, respectively. The process of soaking and cooking with the salt of tartrate and citrate reduced lead by more than 98.5, 99.6 and 99.05% in Indian, Thai and American rice, respectively. The effect of the cooking process compared with soaking had a more significant effect on lead removal ($P<0.05$). Tartrate had a greater effect on the removal of this heavy metal than citrate ($P<0.05$), and soaking and cooking treatment could more significantly reduce the amount of lead. The sensory evaluation of samples showed that there was no statistically significant difference between treatments ($P>0.05$).

Keywords: Chelating Agents, Lead Removal, Rice, Sensory Evaluation, Soaking and Cooking Treatment

Introduction

Rice after wheat is one of the most widely used grains in the world, especially in Asian countries, and accounts for 70% of its daily calories (Ziarati & Moslehishad, 2017). Pollution of soil and water with heavy metals is one of the most important environmental stresses for plants, and these metals can endanger human life through the food chain. Heavy metal poisoning can lead to complications such as neurological disorders, types of cancers, nutrient deficiency, hormonal balance, abortion, respiratory and cardiovascular disorders, liver, kidneys and brain damage allergies, infestations, premature aging, memory reduction, hair loss, osteoporosis, insomnia, weakening of the immune system, anemia, destruction of genes and even death (Chaney *et al.*, 2004). Regarding the contamination of imported rice with lead, simple solutions such as soaking rice in ordinary water have been presented and to some extent have reduced the number of heavy metals. Therefore, the purpose of this study was to determine the concentration of lead in some external rice cultivars and to remove this element by chelating agents (potassium tartrate and citrate) during the wetting, cooking, and simultaneous soaking and cooking of rice.

Materials and methods

Treatments used in this research including: Blank (Control), SC-Blank (Soaking and cooking without the presence of chelating agents in boiling water), S-Tar (Soaking in the presence of potassium tartrate), S-Cit (Soaking in the presence of potassium citrate), C-Tar (Cooking in the presence of potassium tartrate), C-Cit (Cooking in the presence of potassium citrate), SC-Tar (Soaking and cooking in the presence of potassium tartrate), and SC-Cit (Soaking and cooking in the presence of potassium citrate). Measurements of Lead by atomic absorption were carried out (Adibi, Mazhari, Bidoki, & Mahmoodi, 2014).

Results and discussion

The interaction between treatments and rice type on lead removal

According to the results of Table (1) for Indian and Thai rice, there was a significant difference between different treatments with a control sample in terms of lead removal (P<0.05). No significant difference was observed between S-Tar and S-Cit treatments. In addition, no significant difference was observed between C-Tar and C-Cit treatments. The results showed that the lowest removal rate of lead was related to SC-Blank treatment and the highest removal percentage was related to simultaneous soaking and cooking treatment with potassium tartrate and potassium citrate, which is not significantly different between these two chelating agents in these conditions (P>0.05). Since tartrate and citrate potassium salts increase the displacement and migration of metals from contaminated soils, it can be used as a safe additive in a food for the migration of heavy metals from food products (Wu, Luo, Christie, & Wong, 2003). Yang, Li, Peng, Chen, & Zeng (2016) reported that chelating agents (tartrate and potassium citrate) can remove lead and cadmium significantly from peanut and rapeseed meal. Also, by increasing the concentration of the chelating agents, removal of heavy metals increased and a linear relationship was found between increasing the concentration and increasing the removal efficiency. Potassium tartrate was used as an effective eliminator for the removal of cadmium from rapeseed meal and the efficiency of cadmium removal was 72.02% and the concentration of cadmium decreased from 0.95 to 0.24 mg/kg (concentration of 30 mM potassium tartrate). The results of this study are consistent with the results reported in this study. They observed that increasing the time and temperature of peanut and rapeseed meal treatment in the presence of potassium tartrate and potassium citrate, have a greater effect on the reduction of lead and cadmium content.

Huo, Du, Xue, Niu, & Zhao (2016) used citric acid to remove cadmium from rice and contaminated rice after treatment with citric acid was used to produce starch and protein isolate from rice. In general, according to the previous reports and observations of this study, it can be stated that salts of potassium tartrate and citrate and its acids due to their carboxylic groups and the ability to chelate the metal ions can increase the removal of these compounds from plant sources. According to the leading research results, the performance of potassium tartrate in comparison with potassium citrate is higher in lead removal.

Table 1. Average percentage removal of lead from imported rice after application of the treatments

Treatment	Lead removal (%)		
	India	Thailand	America
Blank	0.00^{fA}±0.00	0.00^{eA}±0.69	0.00^{fA}±0.69
SC-Blank	8.16^{eA}±0.55	15.36^{dA}±0.55	13.13^{eA}±0.55
S-Tar	88.25^{cdB}±0.79	93.37^{cA}±0.79	91.74^{cAB}±0.79
C-Tar	93.80^{bB}±0.72	96.25^{bA}±0.72	95.36^{bA}±0.72
SC-Tar	99.79^{aA}±0.49	99.66^{aA}±0.49	99.53^{aA}±0.49
S-Cit	84.64^{dB}±0.61	92.57^{cA}±0.61	89.16^{dAB}±0.61
C-Cit	89.54^{cB}±0.87	96.50^{bA}±0.87	93.86^{bcA}±0.87
SC-Cit	98.50^{aA}±0.69	99.60^{aA}±0.69	99.05^{aA}±0.69

The results are reported as mean±deviation from the mean of three replicates.
The dissimilar letters in each column and the dissimilar letters in each row indicate a significance of 0.05.

Conclusions

Soaking treatment compared with cooking had less effect on lead removal. Soaking and then cooking treatment could reduce the amount of lead significantly. Tartrate chelating salt in comparison with citrate had more effect on the removal of lead from imported rice.

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