Quantifying Arsenic in Rice Using Neutron Activation Analysis

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Introduction and Background

Rice is a staple grain consumed by over 50% of the world's population. However, arsenic concentrations in rice are increasing worldwide, possibly due to climate change, posing significant health risks including cardiovascular disease, diabetes, and certain cancers. Researchers at Columbia University conducted a study that projected a surge in cancer cases in Asia, the highest consumer of rice, by 2050 linked to rice-arsenic consumption (Wang et al., 2025). The amount of arsenic is seemingly insignificant, on the scale of parts per billion, making it difficult to quantify; here we use Neutron Activation Analysis (NAA) as a means to monitor arsenic concentrations in rice.

Technical Description of NAA

NAA is a non-destructive, highly sensitive technique for elemental analysis. To perform NAA, a sample is placed into a strong neutron field such as from a research reactor. As the stable elements in the sample absorb neutrons some of them will be converted to radioisotopes (be "activated"). The activated sample is then removed from the neutron field and a gamma ray spectrometer is used to analyze the characteristic gamma rays being emitted by the activated elements to identify what is present in the sample. The emissions from the sample are then compared to the emissions from a standard of known composition, and the relative number of gamma rays emitted by the sample and the standard can be used to calculate the amount of each element of interest present in the sample.

This technique was applied to determine the arsenic concentration of 2 rice samples grown in Arkansas. Samples were irradiated in the Maryland University Training Reactor and gamma spectrums were obtained using a high purity germanium detector. Arsenic concentrations were obtained by comparison to European Reference Material ERMBC211: Rice flour (Total As and As species) that was irradiated under the same conditions.

Conclusion and Further Work

The samples were found to have arsenic concentrations of 143 and 134 parts per billion (ppb) by mass, respectively, with an uncertainty of 7.3%. This value falls within reported literature values for arsenic in rice, which range from approximately 60–240 ppb, averaging between 68–188 ppb, indicating that the measured sample is within the typical range (Toxic Metals Found in All Rice Samples in New Report, 2025). The agreement between the calculated value and the expected arsenic range in rice suggests that the standard-based method is reliable for quantifying trace elements

FDA research has found that cancer and other health risks increase proportionally with rice consumption at arsenic levels comparable to those measured in our samples (*Arsenic in Rice and Rice Products Risk Assessment Report*, 2016). These findings reinforce the need for greater public awareness of rice contamination and efforts to reduce arsenic levels in our food. Future research should examine additional rice samples from diverse regions to support soil remediation efforts and strengthen public health protections.

References

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