

A Stable Isotope and Chemometric Framework for Non-targeted Detection of Adulterations in Milk

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Dairy is the most important subsector in the livestock industry in Sri Lanka due to the growing demand for fresh milk and its potential influence on the rural economy. Adulteration of milk reduces its quality and may introduce hazardous substances into the dairy supply chain jeopardizing consumers' health. The present study used stable isotopes to identify adulterations in milk based on multivariate chemometric modelling techniques. Thirty-six authentic milk samples were collected throughout the year from the farm belonging to the Faculty of Veterinary Medicine and Animal Science, University of Peradeniya. A set of adulterated milk samples was prepared with possible adulterants including sodium bicarbonate, hydrogen peroxide, sodium chloride, sugar, urea, vegetable oil and water. The milk components such as fat, casein, and whey, were extracted from all the authentic samples and adulterated milk samples. Samples were analyzed using Isotope Ratio Mass Spectrometer (IRMS) for $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$. The results of isotope compositions of the samples were statistically evaluated using R-Studio version 4.2.0. A preliminary data analysis was carried out using descriptive statistics including box plots and scatter diagrams. Principle component analysis (PCA) was performed to check whether the combined isotopic parameters could be used to distinguish adulterated milk samples from authentic milk samples. A linear discriminant analysis (LDA) and orthogonal projection to latent structures discriminant analysis (OPLS-DA) test was performed to discriminate adulterated milk samples. The results revealed that adulterated milk can be distinguished from authentic milk using stable isotope data combined with chemometrics with classification accuracies of more than 96%. The present study provides empirical evidence on the ability of IRMS in the detection of adulterated cow milk. Further, this study provides insight into non-targeted milk screening for adulterants using stable isotope information and a chemometric framework. Further investigations are required to confirm the promising results of this study.

Keywords: Milk, Authenticity, Isotopes, Chemometrics

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