Researchers develop novel multi-sensor data fusion methods for rapid and accurate compound fertilizer quality detection

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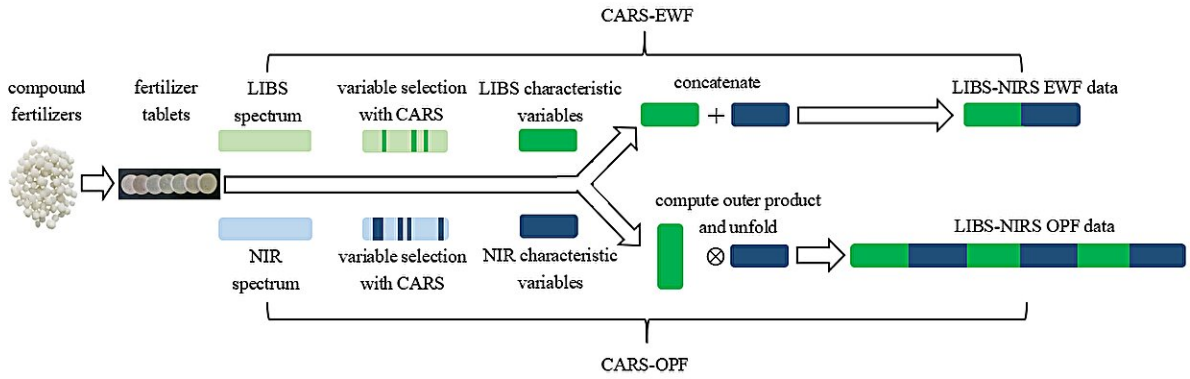

Flowchart of LIBS and NIRS data fusion methods. Credit: Xu Zhuopin

In a study published in *Talanta*, a research team led by Prof. Wu Yuejin from the Hefei Institutes of Physical Science of the Chinese Academy of Sciences has developed a data fusion strategy based on near-infrared spectroscopy (NIRS) and laser-induced breakdown spectroscopy (LIBS) for the rapid and accurate detection of the main components of compound fertilizers.

Compound fertilizer plays a dominant role in the structure of fertilizer products in China, and the content of nitrogen, phosphorus and

potassium is the key index affecting the efficiency and price of compound fertilizer. LIBS and NIRS are two ideal technologies to on-line monitor these main components of compound fertilizer. However, the application of LIBS and NIRS has matrix effects, interference from environmental factors, and the limitation of direct determination of inorganic components.

In this study, the researchers found that by combining spectral data from LIBS and NIRS, as well as combining analytical approaches, it's possible to overcome these limitations and achieve faster detection with improved accuracy.

They used 168 compound fertilizer samples as test objects to analyze the LIBS-NIRS data under different optimization conditions and methods. And found that the LIBS-NIRS data fusion model based on competitive adaptive reweighted sampling combined with outer product fusion (CARS-OPF) and competitive adaptive reweighted sampling combined with equal weight fusion (CARS-EWF) have better quantitative analysis performances than the single spectroscopic methods.

The combination of LIBS-NIRS methods based on CARS-OPF and CARS-EWF shows promise for the rapid and accurate detection of key elemental contents in compound fertilizers. The determination coefficients of prediction (R^2) for the contents of the three elements in compound fertilizers using the proposed LIBS-NIRS models ranged from 89.5% to 96.2%. The results of the best models were improved by 0.25% to 5.62% when compared with those obtained by the NIRS method, and by 10.6% to 33.5% compared with those obtained by the LIBS method.

"Based on this study, we can further combine multiple spectrometers to develop highly accurate detection devices," said Dr. Wang, corresponding author of the study, "it has a good prospect in the

application of online accurate monitoring of compound fertilizer quality."

More information: Zhuopin Xu et al, Rapid and accurate determination methods based on data fusion of laser-induced breakdown spectra and near-infrared spectra for main elemental contents in compound fertilizers, *Talanta* (2023). DOI: 10.1016/j.talanta.2023.125004

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