

## Non-Destructive Determination of Starch Gelatinization, Head Rice Yield, and Aroma Components in Parboiled Rice by Raman and NIR Spectroscopy

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### Streszczenie

Vibrational spectroscopy, including Raman and near-infrared techniques, enables the non-destructive evaluation of starch gelatinization, head rice yield, and aroma-active volatile compounds in parboiled rice subjected to varying soaking and drying conditions. Raman and NIR spectra were collected for rice samples processed under different conditions and integrated with reference analyses to develop and validate partial least squares regression and artificial neural network models. The optimized PLSR model demonstrated strong predictive performance, with  $R^2$  values of 0.9406 and 0.9365 for SG and HRY, respectively, and residual predictive deviations of 3.98 and 3.75 using Raman effective wavelengths. ANN models reached  $R^2$  values of 0.97 for both SG and HRY, with RPDs exceeding 4.2 using NIR effective wavelengths. In the aroma compound analysis, p-Cymene exhibited the highest predictive accuracy, with  $R^2$  values of 0.9916 for calibration, and 0.9814 for cross-validation. Other volatiles, such as 1-Octen-3-ol, nonanal, benzaldehyde, and limonene, demonstrated high predictive reliability ( $R^2 \geq 0.93$ ; RPD > 3.0). Conversely, farnesene, menthol, and menthone showed poor predictability ( $R^2 < 0.15$ ; RPD < 0.4). Principal component analysis revealed that the first principal component explained 90% of the total variance in the Raman dataset and 71% in the NIR dataset. Hotelling's  $T^2$  analysis identifies influential outliers and enhances model robustness. Optimal processing conditions for achieving maximum HRY and SG values were determined at 65 °C soaking for 180 min, followed by drying at 70 °C. This study underscores the potential of integrating vibrational spectroscopy with machine learning techniques and targeted wavelength selection for the high-throughput, accurate, and scalable quality evaluation of parboiled rice.

## Typ publikacji

Artykuł

## Słowa kluczowe

parboiled rice, Raman spectroscopy, starch gelatinization, head rice yield, aroma components

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