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Abstract

Rapid Detection of Rice Adulteration using a Low-Cost Electronic Nose and Machine Learning Modelling

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Abstract: Food fraud is one of the issues that may threaten consumers' trust and confidence in the food industry. Detecting food fraud such as rice adulteration is challenging since the adulterant looks identical to authentic rice. Moreover, the detection procedure is commonly time-consuming and requires high-cost instruments to analyze the samples in the laboratory. Therefore, this study aimed to develop a rapid method to detect rice adulteration using a low-cost and portable electronic nose (e-nose) coupled with machine learning (ML). Six types of adultered rice samples were prepared by mixing the authentic rice (i.e., premium grade rice, organic rice, aromatic rice) with the respective adulterants (i.e., regular grade rice, rice from a different origin, non-organic rice, and non-aromatic rice) from 0% to 100% with a 10% increment by weight. Artificial Neural Networks (ANN) were used to develop prediction models to estimate the adulteration levels using the e-nose sensor readings acquired from the rice samples as inputs. The ML models showed that the e-nose sensors successfully predicted the six types of adulterated rice samples at various adulteration levels from 0% to 100% with high accuracy (Model 1, correlation coefficient, R = 0.95, Model 2 = 0.92, Model 3 = 0.96, Model 4 = 0.96, Model 5 = 0.98, and Model 6 = 0.94). The proposed method effectively detects various combinations of adulterated rice at different mixing ratios using rapid, contactless, portable, and low-cost digital sensing devices combined with machine learning. This may help the rice industry to fight rice fraud effectively and ensure high product compliance with food quality and safety standards.

Keywords: non-destructive assessment; food fraud; authentic; gas sensors; artificial neural networks

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