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用电子鼻区分霉变燕麦及其传感器阵列优化

Discrimination of mildewed oats using electronic nose and optimization of its sensor array

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中文摘要:

应用电子鼻对燕麦（Avena sativa L）霉变程度进行区分，为了提高区分准确度，对电子鼻传感器阵列进行了优化的研究。每天随机选择10个燕麦样品进行电子鼻检
试验连续进行5 d，将检测数据耦合入非线性双稳态随机共振系统，以外部Gaussian白噪声激励系统产生共振，选择输出信噪比特征值进行主成分分析，初期试验主成分
主成分2贡献率之和为96.43%，且相同霉变程度样品离散度较大，不同霉变程度样品之间距离较近。为了提高电子鼻对霉变燕麦样品区分效果，进行了电子鼻传感器负
载分析，优化选择了传感器阵列，优化后主成分1和主成分2贡献率之和为99.31%，相同霉变程度燕麦样品的聚合度更高，使不同霉变程度燕麦样品之间的区分更加明显
进一步的定量化检测奠定了基础。

英文摘要:

Abstract: Oats (Avena Sativa L.) are one of the important food crops. It contains some rich nutrients. Oats easily gets mildew affected by environmental factors during storage
which is getting to be one of problems in the food safety field. As one artificial olfactory analysis method, the electronic nose technique is widely applied in crop quality detecting
fields. This technique utilizes a gas sensor array to imitate a human's olfactory system. The detecting signals measured by a gas sensor array is discriminated and recognized by a
artificial pattern recognition method. Then the species of the detecting objectives can be determined. In this paper, electronic nose system was utilized to discriminate mildewed o
samples. The diagram includes three main parts: data acquisition and transmitting unit, sensor array and the chamber unit, and power and gas supply unit. The sensor array consi
of eight semiconductor gas sensors. Polytetrafluorethylene (PTFE) material was utilized to fabricate the chamber. Each sensor room was separated, which helped to eliminate the
influence of the gas flow. At the same time, gas sensor array optimization was also studied. 25 g of oat samples were weighed and placed into an experimental container. The conta
was tightly sealed with parafilm. 40 samples were prepared. All samples were stored under room temperature and standard atmospheric pressure. In order to accelerate the mildew
procedure of the samples, 4 mL deionized water was sprayed on all samples every day. 10 samples were randomly selected in an electronic nose measurement. The measurement ti
each oat sample was 45 s. The experiments lasted for five days. The measurement data was measured and transmitted to the computer. The stochastic resonance had three princip
parts: a weak input signal, a non-linear bistable system, and an additional dose of external Gaussian white noise. The experimental data was coupled into a non-linear bistable
stochastic resonance model. Stepping external Gaussian stimulating white noise was utilized to modulate the stochastic resonance system for resonance generation. Finally, stoch
resonance signal-to-noise ratio (SNR) was calculated and exported as signal-to-noise ratio curves. Eigen values of systematic output signal-to-noise ratio were selected for princip
component analysis (PCA). The total degree of contribution of the first principal component and the second principal component was 96.43%. In order to improve the mildewed o
discrimination rate, sensor loadings analysis was used to evaluate the contribution rate of all gas sensors. The optimized gas sensor array included S1, S2, S3, S4, S5, S6 and S7. A
an optimization procedure, the total degree of contribution of the first principal component and the second principal component was 99.31%. These results demonstrated that an

electronic nose system presents a discriminating ability for mildewed oat samples. Sensor array optimization based loadings analysis improved the discriminating rate. The propos
method is promising in the crop quality and safety analysis field.