December 2014 Vol. 21 No. 4 54-60
Journal of Northeast Agricultural University (English Edition)

ScienceDirect
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Rapid Non-destructive Detection for Molds Colony of Paddy Rice Based on Near Infrared Spectroscopy

Zhang Qiang[1], Liu Cheng-hai[1], Sun Jing-kun[1], Cui Yi-juan[2], Li Qun[1], Jia Fu-guo[1], and Zheng Xian-zhe[1*]

[1] College of Engineering, Northeast Agricultural University, Harbin 150030, China

[2] Food Processing Research Institute, Heilongjiang Academy of Agricultural Sciences, Harbin 150086, China

Abstract: Near infrared spectrometer technology under a wavelength range of 918-1045 nm was used to rapidly detect paddy rice that was stored at 5℃, 15℃ and 25℃. A total of 121 paddy rice samples were collected from artificial infection with moulds to build the calibration models to calculate the total number colony of moulds based on the principal component regression method and multiple linear regression method. The results of statistical analysis indicated that multiple linear regression method was applicable to the detection of the total number colony of moulds. The correlation of calibration data set was 0.943. The correlation of prediction data set was 0.897. Therefore, the result showed that near infrared spectroscopy could be a useful instrumental method for determining the total number colony of moulds in paddy rice. The near infrared spectroscopy methodology could be applied for monitoring mould contamination in postharvest paddy rice during storage and might become a powerful tool for monitoring the safety of the grain.

Key words: near infrared spectroscopy, paddy rice, moulds, multiple linear regression, principal component analysis

CLC number: TS207.3 **Document code:** A **Article ID:** 1006-8104(2014)-04-0054-07

Introduction

Paddy rice is susceptible to contamination by moulds during storage due to factors affecting storage temperature and moisture. Certain moulds can produce mycotoxins, including the very harmful Aflatoxin B_1, which is common in paddy rice (Binder, 2007; Shephard, 2008; Ni *et al*., 2011). Therefore, it is necessary to establish a rapid, simple and effective method for detection of total number colony of moulds in paddy rice.

A variety of well-established methodologies for analyzing moulds in cereal grains have been tested by American Association of Cereal Chemists (AACC) and the United States Department of Agriculture (USDA) (AACC International, 2000; USDA, 2004). These existing methods include plate culture method. These chemical-based laboratory methods have the advantage of being precise and accurate. However, they are time-consuming, laborious, expensive, and require a well-equipped laboratory and skilled laboratory personnel to perform and interpret these tests. The lengthy process precludes rapid and real-

Received 30 November 2014
Supported by the National 12th Five-year Plan for Science & Technology Support Fund (2012BAK08B04-02); the Heilongjiang Science and Technology Plan (GC12B404)
Zhang Qiang (1986-), male, Ph. D student, engaged in the research of agricultural product detection technology and equipment. E-mail: xiaoqiang20071006@163.com
* Corresponding author. Zheng Xian-zhe, Ph. D, professor, supervisor of Ph. D student, engaged in the research of agricultural product processing technology. E-mail: zhengxz@neau.edu.cn

time detection of moulds in grains.

Near infrared spectroscopy (NIRS) is an excellent candidate for measurements of the chemical components in complex materials including cereals, fruits and vegetables (Millar *et al*., 1996). It has been used to measure the content of water, oil, fiber, starch, and protein in cereals and grains (McClure, 2003). More recently, NIRS has also been successfully applied to predict fumonisin B_1 in maize, deoxynivalenol in wheat and Aflatoxin B_1 in paddy rice (Beardo *et al*., 2005; Abramovic *et al*., 2007; Zhang *et al*., 2014). Tripathi and Mishra (2009) observed that Fourier transform near infrared spectroscopy could be used for rapid, non-destructive quantification of AFB_1 in red chili powder. Sirisomboon *et al*. (2013) found that NIRS could accurately detect the incidence of rice infected by aflatoxigenic fungi. Hu *et al*. (2014) observed that near infrared spectroscopy could be used for rapid and non-destructive quantification of yeast in fresh jujube.

However, very few studies have applied NIRS technology to detect and quantify total number colony of mould contamination in paddy rice. Therefore, the objectives of the present research were to assess the feasibility of using NIRS to detect total number colony of mould concentration in artificially contaminated paddy rice samples and to explore the potential of the method for the prediction of contamination in unknown paddy rice.

Materials and Methods

Paddy rice samples

In this study, paddy rice samples were collected at the experiment station of the Northeast Agricultural University, Harbin, China. The paddy rice samples were harvested in October in 2013. The collected paddy rice was stored for 3 months at temperature of (20±3)℃ and in relative humidity of 55%-65%. The initial moisture content was 10.0% (w.b.). Moisture content of paddy rice samples was measured based on AOAC (1995b) official method (oven dry method, 135℃, 3 h).

Equipments

Humidity chamber (CTHI-150(A)B type, temperature fluctuation ±0.2℃, Shi Dukai Equipment Co., Ltd., Shanghai, China); super clean bench (SE-CJ-10 type, Suzhou Jinghua Equipment Co., Ltd., Suzhou, China); Near infrared spectrometer (ZX-888 type, Osbert International Co., Ltd., San Francisco, USA).

Artificially induced infection in paddy rice samples

Storage experimentations were carried out to obtain moulds contaminated samples. Artificially contaminated paddy rice samples containing different moisture levels (10%-22%) (w.b.) were obtained by adding water to induce the growth of moulds for 3 months in a room at a controlled temperature of 5℃, 15℃, and 25℃. All the tests were performed in triplicate. Data were expressed as mean of triplicate determinations.

Near infrared scanning

A total of 121 samples were selected. The set of samples was divided into two subsets. The larger set (90 samples) was used to calibrate NIRS analysis and to cross-validate the derived equation. The smaller set (31 samples) was used to test the goodness of fit of the calibration model. All paddy rice samples were measured in duplicate. The paddy rice samples were first used for NIR analysis. Then these samples were used in the reference method. Each scan consisted of a sample of 45 g being placed in a quartz cup and the samples were then scanned using a near infrared spectrometer (ZX-888 type, Osbert International Co., Ltd., San Francisco, USA) in diffuse reflection mode. NIR was in a range of wavelengths of 918-1 045 nm. Spectra of each sample were automatically recorded as Absorbance (A) corresponding to log (1/R). The scanning time of each sample was approximately 30 s. Each sample was scanned three times and the average spectrum of the sample was employed for data analysis.

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