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# 豆粕中三聚氰胺显微近红外成像检测的扫描条件优化

# Optimization of scanning conditions on near-infrared microscopic imaging for melamine detection in soybean meal

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中文摘要:

为了确定豆粕中三聚氰胺显微近红外成像检测的最佳扫描条件，该文研究了扫描条件对显微近红外光谱图像质量、采集效率和豆粕中三聚氰胺检测效果的影响。针对不同光谱分辨率和扫描次数对光谱图像均方根噪声（RMS）的影响进行了单因素方差分析试验，对干涉仪动镜移动速度（1、2.2 cm/s）、空间分辨率（25、50 μm）、光谱分辨率（8、16、32 cm-1）和扫描次数（4、8、16次）进行了多因素正交试验方差分析，结果得出光谱分辨率对RMS有显著性影响，而且采用不同扫描条件时显微近红外图像采集时间相差很大。根据图像质量、采集效率和豆粕中三聚氰胺检测效果分别得出优选扫描条件，综合考虑上述3个方面，最终推荐采用的扫描条件为空间分辨率为25 μm，干涉仪动镜移动速度为1 cm/s，光谱分辨率为32 cm-1，扫描次数为4次。该研究同时表明显微近红外成像技术可应用于豆粕中三聚氰胺的检测。

英文摘要:

Abstract: Melamine is used as a non-protein nitrogen adulterant in soybean meal to increase the protein content, and it is harmful to the animals. The existing conventional detecting techniques have the shortcomings of complex pretreatment, high cost, and cannot achieve online detection. Near-infrared microscopic (NIRM) imaging technology combines the spectral and imaging technology. It can detect the material compositions and visualize the position. However, different scanning condition will affect the NIRM image quality and the detecting effect. In this article, a Spotlight 400 NIRM imaging system was used to acquire the NIRM images of the samples. The influence of the scanning condition on NIRM image quality and detection performance of the melamine in soybean meal was studied, and the scanning condition of melamine detection in soybean meal by NIRM imaging was optimized. At first, 10 samples in which the melamine particles were placed on the soybean meal particle, under the soybean meal particle, and beside the soybean meal particle were prepared, and the images were scanned. The influence of different resolution and scan times on the spectral image root mean square noise (RMS) were examined by one-way ANOVA analysis. The results reflected that the levels of 8, 16, 32, 64 cm-1 of spectral resolution and the 4, 8, 16 scans per pixel didn't significantly influence on RMS. Different interferometer speed (1, 2.2 cm/s), pixel size (25, 50 μm), resolution (8, 16, 32 cm-1) and scans per pixel (4, 8, 16) were analyzed by the multi-factor orthogonal experiment. The results showed that resolution had a significant influence on RMS and the optimized scanning condition (test program 10) was as follows: pixel size=50 μm, interferometer speed=1 cm/s, resolution=32cm-1, scans per pixel=16. Meanwhile the following most efficient scanning condition (test program 11) was obtained: pixel size=50 μm, interferometer speed=1 cm/s, resolution=32 cm-1, scans per pixel=4. Considering that the melamine particle size may be less than 50μm, another scanning condition (test program 5) was set by changing the pixel size of the most efficient scanning condition to 25μm. Then, in order to inspect the influence on melamine detection, three other samples were prepared to compare the detection performance of melamine in soybean meal with the optimized scanning condition of test program 5, 10 and 11. One sample was prepared with the melamine particles placed under 4 soybean meal particles of different thicknesses. The other two samples were the mixture samples artificially contaminated with 1% melamine, and the melamine particle size was less than and more than 50 μm, respectively. The results showed that the scanning condition of test program 5 had obtained a more accurate melamine detecting result for the mixture sample contaminated with 1% melamine of particle size less than 50 μm because the pixel size was 25 μm. There was little difference between the three scanning conditions for the other samples. Therefore, considering the optimized scanning conditions obtained by the image quality, the scanning time, and the detection performance of the melamine in soybean meal, the final scanning conditions were recommended as follows: pixel size=25 μm, interferometer speed=1 cm/s, resolution= 32 cm-1, scans per pixel=4. The study also indicated that NIRM imaging technology could effectively detect melamine in soybean meal.

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