Application of near infrared technology in the milling industry

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Introduction

The physical state, including the hardness of wheat grain is a function of its chemical composition and the relationships between the constituents. During milling wheat into flour the structure of the grain is changing. Near infrared (NIR) reflectance technology has its origin in fundamental absorbances of energy, which arise because of changes in the state of molecules. This paper describes some applications of NIR technology to study changes in the characteristics of wheat particles during flour-milling.

A computer model was developed to describe the relationship between log 1/*R* data of the instrument (a NIRSystems Model 4500 scanning NIR spectrophotometer) and the physical parameters of the grain. The model was used for computer simulation of changes in the chemical and physical characteristics of the grain during milling. The chemical component of the computer model was related to the chemical composition of the grain. The physical component of the model was related to the structure of the grain particles. For the mathematical derivation of the model, chemical composition was used together with an entropy characteristic, which represented the structure component.

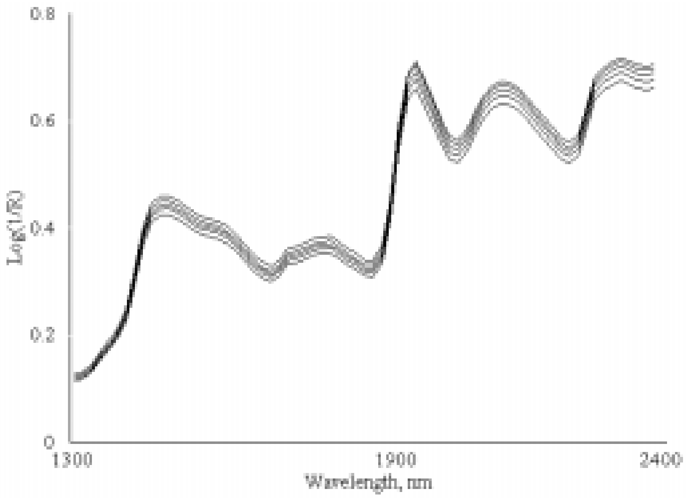

Figure 1. Near infrared spectra of different wheat millings.

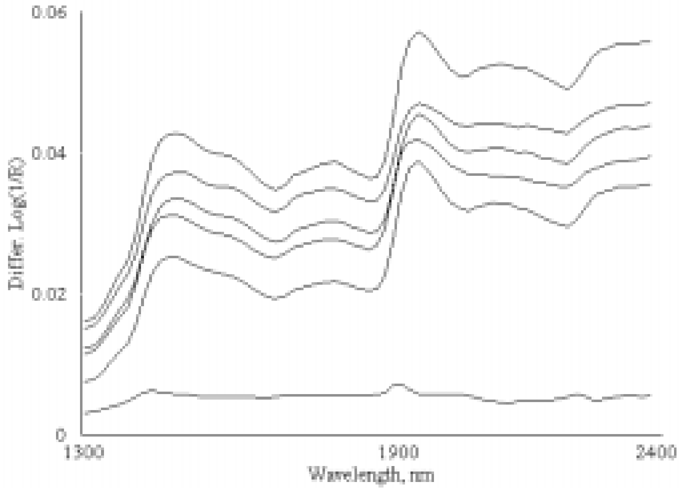

Figure 2. Difference spectra incurred by changes in mill-roll clearance.

The computer simulation, using the model, produced curves representing log 1/*R* data, which were correlated to parameters such as particle size. These illustrated that differences between the curves were caused by physical or structural changes.

Results

During the study clearances between rolls in the commercial roller-mill stands were changed in uniform pitches and samples were taken at each step. Figure 1 shows NIR spectra, which were recorded at each step.

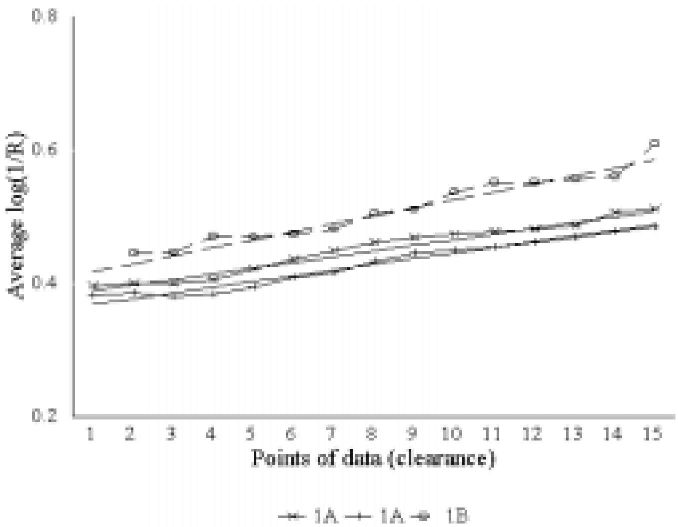

Figure 3. Difference spectra incurred by changes in mill-roll clearance—reverse trend.

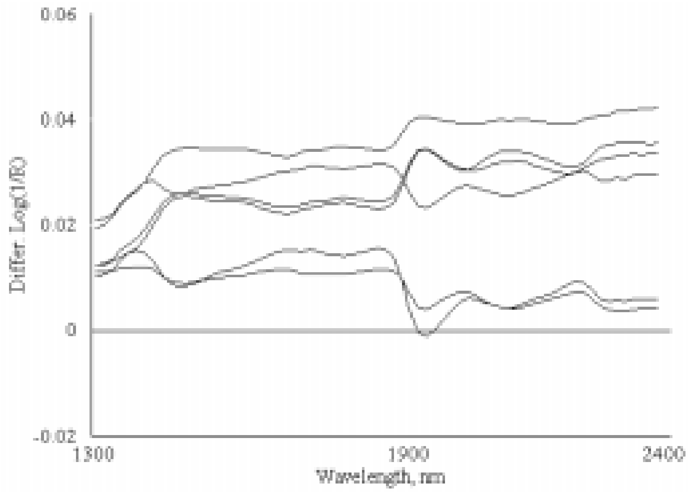

Figure 4. Changes in average logarithmic coefficients of spectra induced by changes in milling practice.

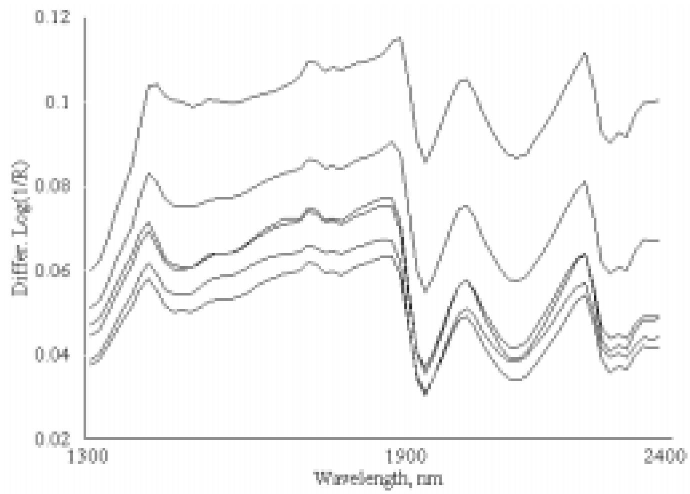

Figure 5. Changes in spectra of ground wheat induced by changes in grinding time.

Figure 2 shows the difference curves between the spectra, as calculated by NIRSystems NSAS software. The sequence clearly indicates the changes in the spectra as the milling system became more severe and more energy was expended in the milling.

Figure 3 illustrates the patterns obtained by subtracting the second, and up to the fifteenth curve from the first, and shows a negative trend.

The differences in the average logarithmic coefficients were calculated to characterise the spectra. These are plotted in Figure 4. The logarithmic coefficient is constant for a given milling system, and is related to the type of wheat being milled.

The last figure illustrates changes in spectra of two different types of wheat milled by a different system. A laboratory mill was used with a closed chamber. Different particle characteristics of the wheat were induced by grinding for different periods (20, 40, 60, 80 and 100 seconds). The difference “spectra” are plotted in Figure 5, and represent differences of 20, 40, 60 and 80 seconds between the first and fifth grinding period.

The pattern of the changes in the subtracted spectra were similar to those given in Figure 3. This indicates that changes in milling/grinding practice which cause changes in particle characteristics influence the spectra in similar ways, even if the methods of grinding differ.

Conclusions

Differences in diffuse reflectance coefficients caused by changes in the severity of grinding wheat are consistent with physical changes in the material. The physical differences in the spectra are believed to be linearly related to the energy involved in creating the differences in particle characteristics that result in differences in the spectra.