Application of near infrared spectroscopy for quality evaluation of an intact apple

Rae Kwang Cho, Young Kil Kwon and Kyung Hee Lee
Department of Agricultural Chemistry, Kyung-pook University, Taegu 702–701, Korea.

Mutsuo Iwamoto
Ministry of Agriculture, Forestry and Fisheries, Tokyo 100, Japan.

Introduction

Quality evaluation of fruits and vegetables has traditionally been based on external parameters including such factors as colour, shape, bruise and size. In recent years, internal parameters such as sweetness, acidity, moisture and firmness became much more important for evaluating apple quality. However, conventional analysis of internal quality factors of fresh fruits has been carried out by measuring brix with a refractometer, firmness with a penetrometer and acidity with a titrator, after removal of the skin and extraction of the juice.

Our laboratory has investigated the application of near infrared (NIR) spectroscopy for determining the internal factors of apple fruits since 1990.[1]

This paper presents the error sources due to the various sample conditions and differences in physicochemical analysis. Improved prediction accuracy is reported including future utilization of the NIR method.

Materials and methods

Sample

Apples used in this study were produced in the Kyung-pook province of Korea. The Fuji apples were harvested in November 1993 and 1994. In total 1500 apples were used after storage at 5°C and in a controlled atmosphere.

Physicochemical analysis

Firmness of the intact apple was measured by using a penetrometer (Kiya Co.) with or without fixing tools as shown in Figure 1. Brix degree of the extracted juice was measured with a digital refractometer (Atago PR1). Acidity of the juice was by titration with 0.01 N NaOH solution. Moisture content was determined by a vacuum drier or freezing drier.

NIR spectra acquisition

Near infrared reflectance spectra of apple was measured using InfraAlyzer 500 and InfraAlyzer 400 (Bran+Luebbe). Two kinds of sample loader were developed to ease sample presentation of the apple, as shown in Figure 1.

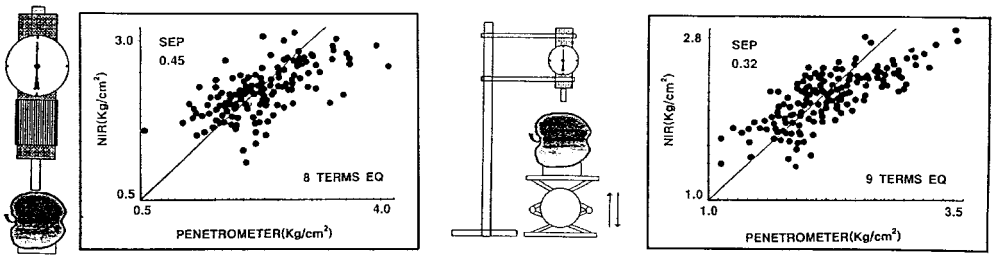

Figure 1. Comparison of the accuracy for firmness due to the difference of physical measurement.

Data analysis

Multiple linear regression analysis was conducted using InfraAlyzer Data Analysis Software (IDAS) program (Bran+Luebbe). IDAS-UTIL software were developed and used. This software has a simple IDAS program, which for instance, provides fast chemical data input, automatic sample group dividing for multiple linear regression analysis, fast summaries and brief presentation of the calibrating or validation result on one sheet of paper.

Result and discussion

The results of multiple linear regression analysis for apple firmness are shown in Figure 1. From the comparison of the *SEP*, due to the difference of physical firmness detection method, the method to keep fixation resulted in fairly good accuracy.

In addition, the freeze drying method for moisture determination appeared fairly accurate in *SEP*, as shown in Figure 2. Concerning the development of a NIR equation for acidity and brix, the effect of browning of the sample juice was determined. But the effect of heat treatment for deactivation of polyphenol oxidase was not significant.

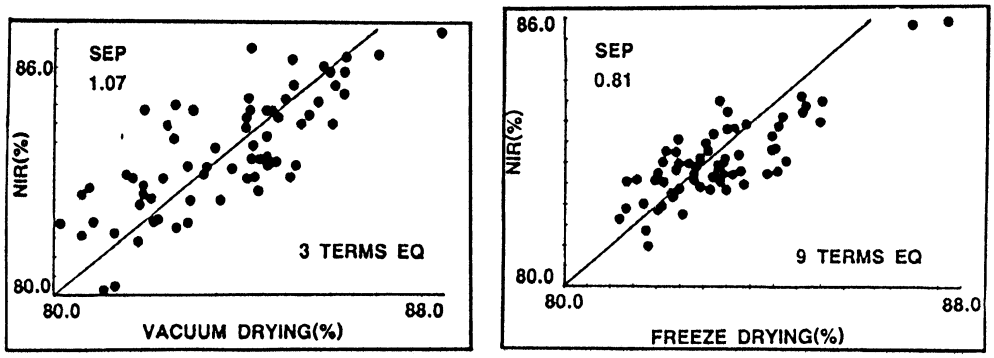

Figure 2. Comparison of the accuracy for moisture due to the difference of physical measurement.

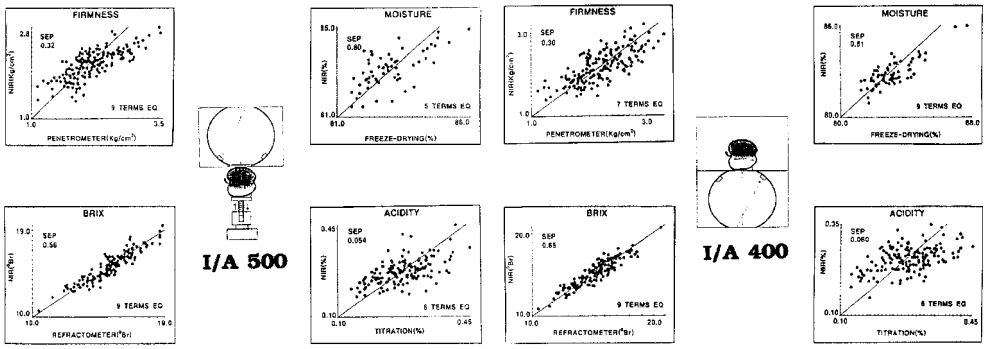

Figure 3. Result of the precision for apple quality factor InfraAlyzer 500 and InfraAlyzer 400.

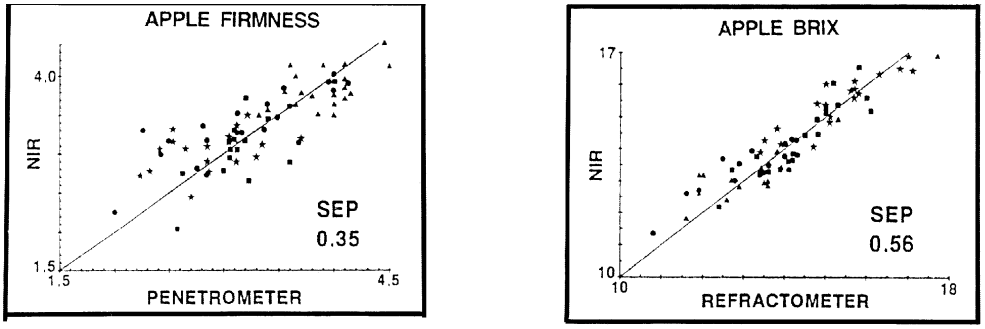

Figure 4. Development of universal equation for brix and firmness of apple.

The result of the precision determined by using the InfraAlyzer 500 or filter type NIR instrument InfraAlyzer 400 are summarized in Figure 3. From the comparison, it is considered that brix and firmness can be determined even with filter type NIR instrument.

Subsequently, the universal equation for brix and firmness of apple was developed to meet different sample conditions such as storage method or bagging, as shown in Figure 4.

Finally, we hope to demonstrate the prospect of NIR developed for apple transportation, such as monitoring the changes of quality during storage and overall expression of apple quality.

Reference

1. R.K. Cho, K.H. Lee and M. Iwamoto, *The Proceeding of the International Diffuse Reflectance Spectroscopy Conference.* Chambersburg, USA, pp. 7176 (1989).