Evaluating viscosity of cassava starch by using near infrared spectroscopy

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Introduction

Viscosity of starch is an important quality factor of starch to make a range of products. Maximum viscosity is the viscosity that starch granules reach when they gelatinize during heating in the presence of water. Using the Brabender Micro Visco-Amylo-Graph setback shows the viscosity of the gelatinized starch during the cooling period after gelatinization. The gelatinization behaviour depends on the kind of starch. The Visco- Amylograph takes time, the instrument is costly, destroys the sample, and experience is required for its effective use.

NIR Spectroscopy is an effective technique widely-used to predict constituents and parameters such as moisture, protein, starch, and sweetness. If viscosity in cassava starch could be effectively evaluated by NIR Spectroscopy, it would be useful for cassava starch mills, and cassava processing. The NIRS technique is cheaper, takes much less time, and is non destructive of samples, while the accuracy and precision are sufficient to serve as a substitute for standard laboratory methods. The technique has been applied to many crops, including dry matter in onion,[1] soluble solids in cantaloupe,[2] brix in peach,[3] and moisture, starch and protein in wheat. The present study was to evaluate the prediction of viscosity of cassava starch by Near Infrared Spectroscopy.

Materials and methods

The measurements were conducted at the Postharvest and Processing Research Development Office in the year 2009.

Sample

A total of 139 samples of cassava starch were collected from factories and markets.

Reference analysis

Viscosity in terms of maximum viscosity, set-back and break down were analyzed by a Brabender Micro Visco-Amylo-Graph.

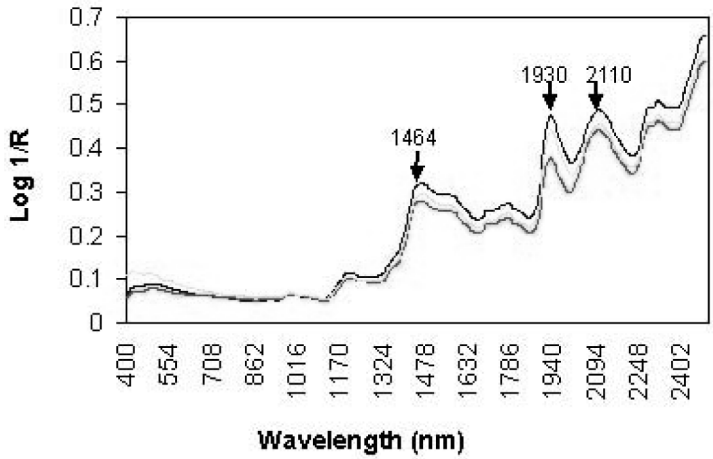

Figure 1. Original spectra of cassava starch in the wavelength region 800–2500 nm.

NIR spectra acquisition

NIR spectra of rice samples were measured by a Foss/NIRSystems Model 6500 operated in reflectance mode for the wavelength region of 800–2500 nm in reflection mode. Original spectra are shown in Figure 1. Sample characteristics are given in Table 1.

Data analysis

PLS analysis of the Unscrambler software (Camo, Oslo, Norway) was used in calculation. Full cross validation was used to evaluate the calibration equations developed.

Results and discussion

PLS calibration results developed from original spectra for prediction of the viscosity (BU) in cassava starch are shown in Table 2.

Table 1. Characteristics of the cassava starch samples used.

Items	Maximum	Break down	Set back
No. of samples	139	139	139
Min–Max	306–765	146–353	40–450
Mean value	504.9	255.9	251.1
SD	113.79	41.88	120.73
Unit used	BU	BU	BU

Table 2. PLS calibration results for viscosity measurement of cassava starch.

Viscosity	Math method	Wavelength region (nm)	F	R	SEC	SECV	Bias
Maximum	Original	800–2500	14	0.94	37.61	48.83	0.09
Breakdown	Original	1000–2500	13	0.76	26.61	34.23	–0.10
Set back	Original	800–2500	14	0.96	33.96	44.49	0.25

F: the number of factors used in the calibration equation; *R*: multiple correlation coefficient; *SEC*: standard error of calibration; *SECV*: Standard error of cross validation; Bias: the average of differences between actual value and NIR value.

Three models were accepted to evaluate viscosity. Set-back was predicted with the best accuracy, followed by maximum viscosity. Breakdown was not well-predicted. A scatter-plot for prediction of the three parameters is illustrated in Figure 2.

The most important wavelengths involved in the development of the PLS model for prediction of maximum viscosity were 910 nm, 1000 nm, 1215 nm, 1410 nm, 1510 nm, 1725 nm, 1900 nm and 2050 nm. The PLS model for prediction of breakdown involved wavelengths at 1097 nm, 1195 nm, 1360 nm, 1510 nm, 1685 nm, 1820 nm, 1940 nm, 1980 nm, 2050 nm and 2252 nm. The PLS model for prediction of set-back involved wavelengths at 910 nm, 1000 nm, 1215 nm, 1410 nm, 1500 nm, 1614 nm, 1870 nm and 2090 nm. Absorption bands in the areas of 910 nm, 1195 nm, 1360 nm, 1510 nm, 1685 nm, 1980 nm and 2050 nm are known to be associated with protein.

Conclusion

NIR spectroscopy has the potential to be an effective technique to evaluate the viscosity parameters of cassava starch. The optimum wavelength ranges were 800–2500 nm of set-back and maximum viscosity, and 1000–2500 nm for viscosity breakdown.

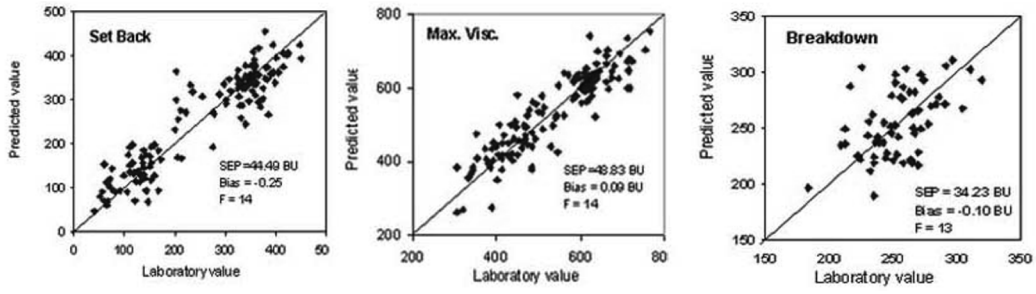

Figure 2. The relationship between lab analysis and predicted viscosity of (a) set back, (b) max. visc. and (c) breakdown.

References

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