Rapid discrimination and determination of curcuminoids content in turmeric rhizome by near infrared spectroscopy

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Introduction

Turmeric (*Curcuma longa*) rhizome is a perennial herb from the Zingiberaceae family.[1,2] Thailand has been one of the countries that can produce and supply large quantities of turmeric and its products, to supply the world market. Its rhizome is used as a spice, a pigment dye,[3] and in traditional medicine. The curcuminoids of turmeric have various pharmacological activities. However, their extraction and determination are very complicated and time-consuming. In this study, we developed a rapid technique for discriminating and determining curcuminoid content in turmeric rhizome, by using near-infrared spectroscopy (NIRS) and chemometrics.

Partial least squares (PLS) regression method was combined with the near infrared (NIR) spectroscopic technique for quantitative and qualitative analysis of turmeric. Two types of turmeric, which are different in geographical origin, were employed in this study. Discriminant PLS (DPLS) and PLS models were developed by using the original and pretreated NIR spectral data, and were compared to obtain the best performance of each model. The results showed that the PLS regression method, coupled with NIR spectroscopy, could be a promising method for quantitative and discriminant analysis of turmerics according to their curcuminoid contents, which are related to their origin.

Experimental

Samples

Two varieties of turmeric were used in this work, cv B47-39 and B51-1. The rhizome was sliced (1 rhizome = 1 sample) and dried at 50 °C in an oven for 2 days before grinding, to particle size of 1 mm by a Cyclotec grinder, model 1093 (Foss, Hillerød, Denmark). The moisture content of each turmeric powder sample was determined by a moisture analyser, model HB43 (Mettler Toledo, Bangkok, Thailand).

NIR Spectral acquisition

The powdered samples were packed in a standard cup. NIR spectra of the 2 types of turmeric powder; 43 samples of B47-39 and 36 samples of B51-1, were collected in the region of 1100–2500 nm, with 2 nm interval by an InfraAlyzer 500 NIR reflectance analyser (BRAN+LUEBBE, Norderstedt, Germany). Each sample was scanned in duplicate, and the averaged NIR spectral data were used for data analysis.

Reference analysis

The curcuminoids in the turmeric powder were extracted by soxhlet extraction. Curcuminoid content was determined by a HPLC model HP1100 (Agilent, California, USA), as the reference method. The content of curcuminoid in each variety is shown in Table 1.

Data analysis

Discriminant PLS (DPLS) and PLS calibrations were calculated by the Unscrambler (Ver. 9.8: CAMO AS, Trondheim, Norway). The NIR spectra were subjected to multiplicative scatter correction (MSC) and 2nd derivative (7-point Savitsky–Golay filter) before developing PLS models for the classification and quantitative determination. Validation was performed on a separate test set.

Results and discussion

In this study, the advantage of using 2nd derivative spectra in the selected region of 1100–1550 nm was apparent in the PLS calibration for the prediction of curcuminoid content in turmeric. This NIR spectral region includes the 1st overtone of O–H around 1460 nm. We obtained a very good

Table 1. Distribution of the curcuminoid contents in turmeric samples.

Variety	Curcuminoid contents (%)			
	Min.	Max.	Mean	*SD*
B47-39	2.44	11.04	6.76	2.02
B51-1	6.18	17.07	12.65	2.64

Table 2. PLS calibration results for predicting content of curcuminoids in turmeric rhizomes.

Pretreatments	Wavelength region (nm)	*F*	*R*	*RMSEC*	*RMSECV*	*RMSEP*
2nd Derivative	Whole	5	0.93	1.31	1.57	1.85
	1100–1550	5	0.92	1.45	1.68	1.49
	1550–2100	4	0.92	1.41	1.63	1.78
	1550–2500	4	0.93	1.37	1.58	1.84
	2100–2500	4	0.93	1.32	1.52	2.04

RMSEC: root mean squared error of calibration, *RMSECV*: root mean squared error of cross validation, *RMSEP*: root mean squared error of prediction, Unit: % for curcuminoids.

model that yielded a high coefficient of correlation of 0.92, and a RMSEP of 1.49%, with 5 factors, when a separate prediction set was used in evaluation (Table 2).

We also obtained a very good DPLS model for classifying two types of turmeric clearly, as B47-39 and B51-1 (Figure 1).

Although, all models gave the same percentage of correct classification, the model developed using the 2nd derivative NIR spectra over the whole wavelength region yielded good statistical results, with an *R*-value of 0.94, and an *RMSEC* of 0.16 with the low PLS factor number of 5 (Table 3).

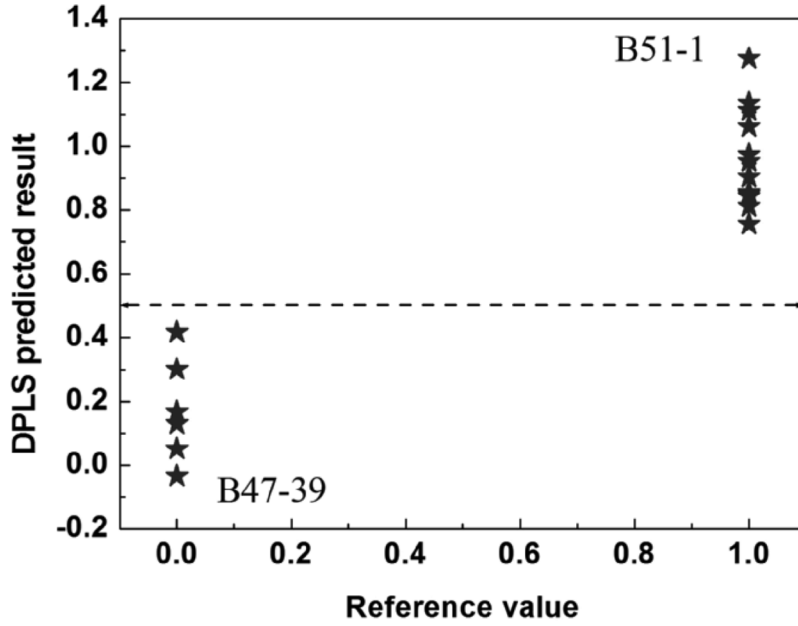

Figure 1. Classification result of the DPLS model built by 2nd derivative spectra in whole region with 100% correct classification.

Table 3. DPLS results obtained from model built by using original and pretreated NIR spectra of turmeric powder in the whole wavelength region.

Pretreatment	DPLS calibration			Correct classification (%)	
	F	*R*	*RMSEC*	B47-39	B51-1
Original	8	0.94	0.16	100	100
MSC	8	0.93	0.18	100	100
2nd Derivative	5	0.94	0.16	100	100

Conclusion

The results discussed above revealed that the NIRS method in combination with PLS regression is a very promising method to quantify curcuminoid content in turmeric, and to classify the type of turmeric samples. This rapid method can replace the traditional HPLC method, which is time consuming and expensive. Moreover, it should be able to identify the origin of turmeric as well as selecting high quality turmeric samples, that have high curcuminoid content.

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