Using near infrared spectroscopy to detect the adulteration of milled rice cv. Khao Dawk Mali 105 with cv. Chainat 1

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Introduction

Rice cv. KDML 105 is very popular in Thailand and international markets, due to its distinct aromatic flavour, softness and chewiness. The latter two properties are highly related to amylose content in the grain. The main problem in KDML 105 trading is the adulteration of the milled rice with variety CN 1 which is similar in size and shape. It is very difficult to detect the adulteration by visual means alone. Traditionally the identification of adulterated milled rice could be done by the alkaline test. However this method is a destructive technique, and is time consuming, needs lots of reagents and is costly.

Near infrared (NIR) spectroscopy is a non-destructive, rapid and accurate method for application to a wide range of analysis, and it is more environmentally friendly compared to conventional chemical techniques.[3] The absorption bands correspond to overtone and combinations of the fundamental vibrations that involve OH, NH and CN groups.[1] The NIR technique can be used to determine the chemical composition of grains and seeds, such as moisture content,[7] protein[10] and amylose contents.[9,5] Moreover, NIR spectroscopy can be used to classify the authentication of Basmati rice and other long-grain rice.[2] So NIR spectroscopy was applied to detect the adulteration of milled rice in this study.

Materials and methods

Milled rice cv. KDML 105 was adulterated with cv. CN 1 at 8%, 16% and 24% by weight. Pure rice cv. KDML 105, and cv. CN 1 (200 g sample) were used for comparison. The total of 80 rice samples for each treatment were packed in the coarse sample cell and reflectance spectra were measured by an NIRSystems Model 6500, over the wavelength region from 1100 nm to 2500 nm.

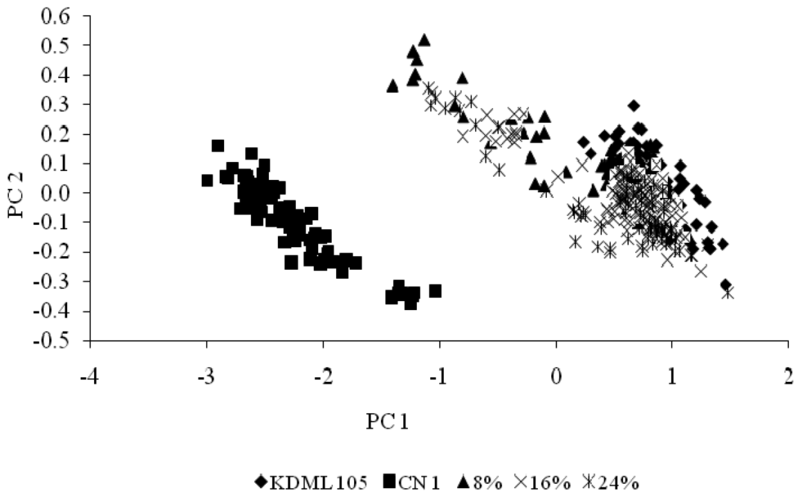

Figure 1. Principal component analysis (PC1 vs. PC2) of KDML 105, CN and the adulterated milled rice at 8%, 16% and 24%.

After scanning, the samples were analysed for amylose content and viscosity, using the iodine colorimetric method and Rapid Visco Analyser (RVA), respectively. The PCA data reduction technique was utilised to find new variables, called principal components (PCs).[1] The technique was used to analyse the original spectral data with no data pretreatment. The means of the data were compared using least significant difference (LSD).

Result and discussion

When PCA was applied to the original spectrum of rice samples it was found that the spectra could be separated into two groups, PC1 and PC2. PC1 explained the maximum possible variance of physical data such as grain shape and size.[2] However, the information related to chemical data

Table 1. Amylose content of KDML 105, CN 1 and adulterating milled rice at 8%, 16% and 24%.

Treatment	Amylose content (%)
KDML 105	19.1 ± 1.63a
8% adt	20.9 ± 1.31b
16% adt	22.2 ± 1.34c
24% adt	23.5 ± 1.80d
CN 1	33.1 ± 1.81e
CV (%)	6.71
$LSD_{(0.05)}$	0.50

Within column means followed by different letter are significantly different ($P < 0.05$) adt: adulterated.

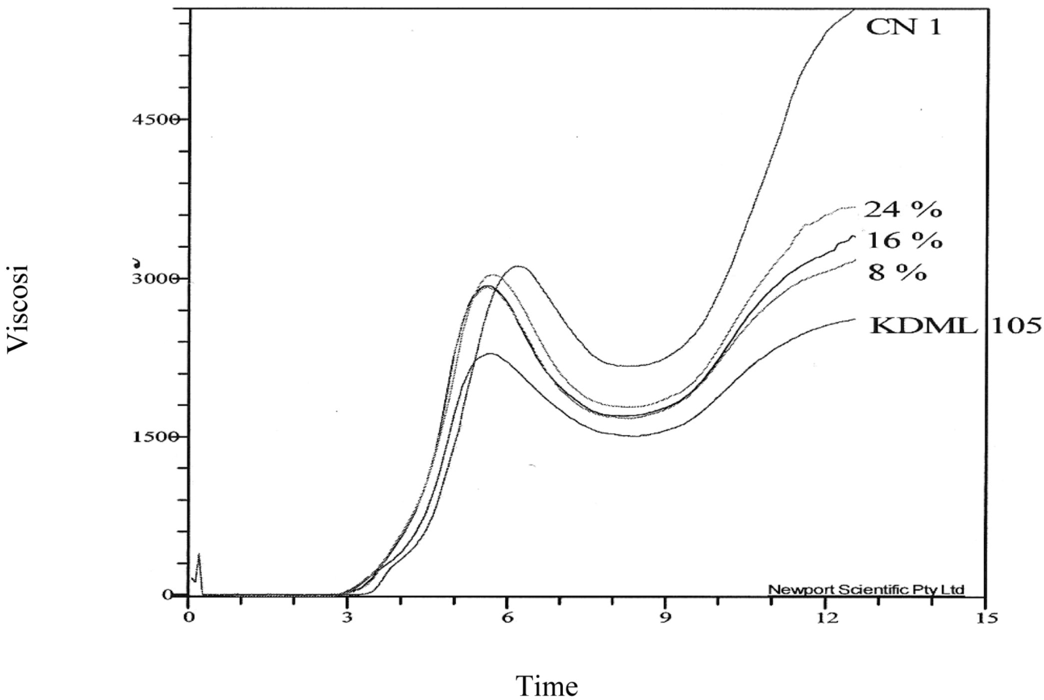

Figure 2. Viscosity curve of KDML 105, CN 1and the adulterating milled rice at 8%, 16% and 24%.

was found in PC2 and upwards of the PCs.[8] The PCA score plot showed the separation of sample groups: the first group was the spectrum of pure rice cv. KDML 105 and the adulterated milled rice at 8%, 16% and 24 %. The second group was the pure rice cv. CN1 (Figure 1).

According to the amylose content, the pure rice cv. CN1 was significantly different from the KDML105, and the adulterated milled rice at 8, 16 and 24 % at $P<0.05$ (Table 1).

Table 2. Viscosity data of KDML 105, CN1 and adulterating milled rice at 8%, 16% and 24%.

Treatments	Peak viscosity (cP)	Final viscosity (cP)	Setback (cP)	Pasting temperature (°C)
KDML105	2396 ± 132.56a	2694 ± 100.55a	297 ± 56.57a	71.2 ± 1.7a
8% adt	2905 ± 75.26b	3182 ± 70.38b	277 ± 51.94a	71.4 ± 1.0a
16% adt	2947 ± 116.74b	3406 ± 98.25b	459 ± 77.70b	72.3 ± 0.9ab
24% adt	3015 ± 108.11c	3670 ± 103.67b	654 ± 39.67c	72.9 ± 1.1b
CN 1	3112 ± 89.40c	5611 ± 146.41c	2499 ± 79.26d	77.4 ± 1.7c
CV (%)	3.69	2.87	7.51	1.82
$LSD_{(0.05)}$	95.92	96.22	80.26	1.19

Within column means followed by different letter are significantly different ($P<0.05$)
adt: adulterated.

Amylose content of rice grains is an essential quality parameter in trading, because it is correlated with the sensory tenderness of cooked rice. It is an important factor in the estimation of rice functional quality, to assess the cooking quality of rice grains or flour.[6] Rice cv. CN 1 contained high amylose content, having a higher peak viscosity, final viscosity, setback and pasting temperature (Figure 2).

It could be explained that rice cv. CN1 was harder to cook than pure rice cv. KDML 105, and the adulterated milled rice. Peak viscosity, final viscosity, setback and pasting temperature of the adulterated milled rice were different from the pure rice of both cultivars (Table 2).

The adulteration had effected an increase in setback. It has been correlated with the texture of the product,[4] and an increase in peak viscosity. This was used to indicate the water binding capacity of starch, which is often correlated with final product quality. The final viscosity is the figure most commonly used to indicate the ability of material to form a viscous paste, or gel, after cooking and cooling. Pasting temperature refers to the cooking temperature. Rice with a high pasting temperature requires more water and time to cook.[6] High amylose has much greater binding force, so it needs more energy than low amylose rice, such as the pure rice cv. KDML 105. The adulteration increased amylose content and affected viscosity properties.

Conclusion

Near infrared spectroscopy could separate milled rice into two groups, based on low and high amylose content. However, the adulteration was not clearly detected, since the KDML 105 and the adulterated rice were intermingled in the same group. Adulteration had a distinct effect on some viscosity properties.

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