CLASSIFICATION OF ORANGE JUICE ADULTERATED BY TABLE SUGAR SOLUTION USING PRINCIPAL COMPONENT ANALYSIS

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ABSTRACT

The near infrared (NIR) spectroscopy was applied in differentiate the pure fresh orange juice from adulterated juice by table sugar solution using principal component analysis. One hundred samples of the juice included 10 samples of 100% fresh juice, 80 samples which were added by 50% w/w sugar solution and water for 16 different levels of orange juices (5 samples for each level) and 50 of purchased juiced from 25 vendors in Bangkok and near-by provinces. The score plot of principal component 1 (PC1) and principal component 2 (PC2) indicated that the NIR spectra of orange juice samples scanned by FT-NIR spectrometer could be fairly classified into different groups and the pure fresh orange juice was separated from the adulterated ones. The score plot showed that the juice samples bought from vendors were in groups of 50:20:30, 40:10:50, 40:20:40 and 30:20:50 of juice: 50%w/w sugar solution: water (by volume). However, there was a vender sold 100% pure fruit juice. This data is useful for customer.

INTRODUCTION

In tropical country, cold beverage is popular especially in summer. Orange juice is a healthy and nutrient-dense beverage(Yang et al., 2013) which contains high levels of valuable nutrients such as vitamin C, potassium, folate, niacin, riboflavin, and magnesium (Rampersaud, 2007).In Bangkok and near-by towns, the orange juice is sold by venders scattering along the roads for convenient of customers. However, there is an adulteration of the juice by sugar solution to reduce the price of the juice. Fruit juices (orange and apple juice) where in the top 7 foods reported from 1980 to 2010 as the most common targets for adulteration (Moore et al., 2012, Jandrić et al., 2014). It is not easy to determine non-destructively or even destructively whether the juice is pure or being adulterated. Pineapple, orange, grapefruit, apple, clementine, and pomelo were investigated for adulteration using chromatographic experiments performed on a Waters ACQUITY™ UPLC™ system connected to Xevo G2 Q-ToF MS equipped with an electrospray ionisation source with multivariate data analysis and adulteration could be detected at 1% (Jandrić et al., 2014). Ammari et al. (2015) assessed the adulteration of orange juice by grapefruit juice by 3D-front-face fluorescence spectro-scopy followed by Independent Components Analysis (ICA) and by classical methods such as free radical scavenging activity and total flavonoid content. The results of this study clearly indicate that frauds by adding grapefruit juice to orange juice can be detected at percentages as low as 1%. Near infrared spectroscopy is a rapid, non-destructive, accurate, environmental friendly technique for determination of constituents in agricultural product and food and also for detection of an adulteration of food. It was applied to orange juice in some cases such as to estimate the saccharose concentration (Benoudjit et al., 2009) and to detect the citric acid and tartaric acid in orange juice (Cen et al., 2007). The obtained results suggest that the NIR approach represents a promising alternative to the traditional methods. Principal components analysis was used to classify the pure orange juice and adulterated ones using 46 volatile constituents (Not NIR spectra) as parameters and it was also possible to classify the orange juice drinks relative to pure juice samples (Shaw et al., 1997). It has been no report on detection of sugar solution adulterated in orange juice using principal component analysis accompanied with NIR spectroscopy. Therefore the objective of this research was to do feasibility study on applying NIR spectroscopy to differentiate the pure fresh orange juice from adulterated juice by table sugar solution using principal component analysis. This information would be useful to customers.

MATERIALS AND METHODS

Samples

There were 10 samples of 100% fresh juices squeezed from oranges (*Citrustangerina*) bought from main agricultural produce distributing market in Pathumthani province, Thailand. There were 80 samples (200 ml each) which were prepared by adding 50% w/w sugar solution and water into 16 different levels of pure orange juices (5 samples for each level) (Table 1). The ratio of the compositions was by volume. There were 50 of purchased juiced from 25 vendors in Bangkok and near-by provinces (2 samples from each vendor).Therefore there were 18 groups in total.

Near infrared spectroscopy

Each sample was scanned using near infrared (NIR) radiation of 12500-3600cm^{-1}through a glass vial of 22 mm covered with a stainless steel transflection plate which provided a 2 mm optical path length using a Multi-Purpose Analyzer (MPA) FT-NIR spectrometer (Bruker, Bremen, Germany) (Figure 1). The scanning was done with a nominal resolution of 8 cm^{-1}, accumulating 32 scans per spectrum using a background of the gold at a room temperature of 25 ± 1 °C. The NIR spectra obtained were classified into 18 groupsusing principal compo-nent analysis OPUS, v.7.0.129 software.

Figure 1. Near infrared scanning of orange juice sample using FT-NIR spectrometer.

RESULTS AND DISCUSSION

Table 1 shows the detail of juice, sugar solution and water mixing ratio at different levels, the number of samples and number of spectra using in principal component analysis. The color of the markers using for each groups of samples is also indicated. Figure 2 shows the score plot of principal component 1 (PC1) and principal component 2 (PC2). It indicated that the NIR spectra of orange juice samples scanned by FT-NIR spectrometer could be fairly classified into different groups and the pure fresh orange juice was separated from the adulterated ones. The score plot showed that the juice samples bought from vendors were in groups of 50:20:30, 40:10:50, 40:20:40 and 30:20:50 of juice:50%w/w sugar solution:water (by volume). However, there was a vender sold 100% pure fruit juice.

Table 1. Number of sample and spectra of each group of different juice, sugar solution and water mixing ratio.

Juice : 50%w/w sugar solution : water (by volume)	Number of samples	Number of spectra	
100:00:00	10	19	
90:10:00	5	10	
80:20:00	5	10	
70:30:00	5	10	
60:40:00	5	12	
50:50:00	5	10	
40:60:00	5	10	
50:10:40	5	10	
50:20:30	5	10	
50:30:20	5	10	
40:10:50	5	10	
40:20:40	5	10	
40:30:30	5	10	
30:20:50	5	10	
30:30:40	5	10	
30:40:30	5	10	
30:50:20	5	10	
Samples from venders	50	97	

Color is for indication of group which will be illustrated in score plot in Figure 2.

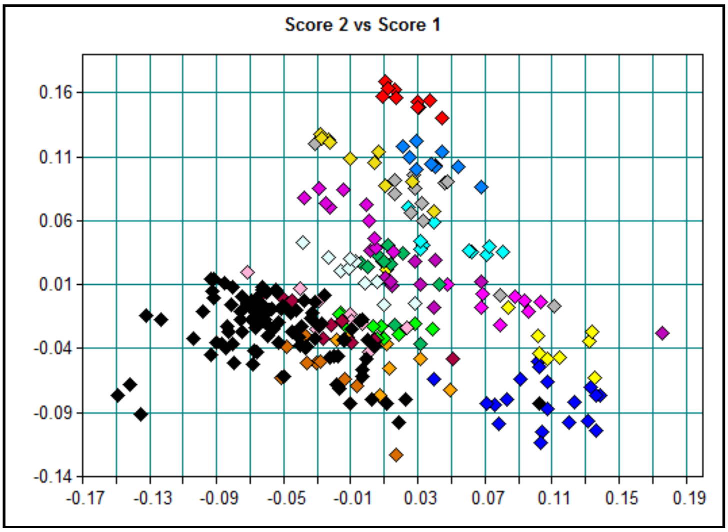

Figure 2. Score plot of principal component 1 (PC1) and principal component 2 (PC2) derived from near infrared spectra of different groups of orange juice. Different color show different group (see Table 1).

CONCLUSION

Near infrared spectroscopy with principal component analysis proved its ability in classification of pure orange juice and sugar solution adulterated ones. This protocol developed in this study is rapid, accurate, and can be substituted the complicated detection methods. It needed no sample preparation and used only a few drops of sample. The food security or food safety organization and related sectors should be encouraged to apply this method to benefit the consumers.

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