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Application of Near-Infrared Spectroscopy for the Detection of Metanil Yellow in Turmeric Powder

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Abstract

Turmeric (*Curcumina Longa*) is a globally traded commodity which is subjected to economically motivated chemically unsafe adulteration, namely metanil yellow. In this work, we report a simplistic and convenient approach to find the adulteration of turmeric with metanil yellow by near-infrared (NIR) spectroscopy coupled with chemometrics. Pure turmeric sample was prepared in the laboratory and spiked with different concentrations of metanil yellow. The reflectance spectra of 248 pure turmeric, metanil yellow, and adulterated samples (1–25%) (*w*/*w*) were collected using NIR spectroscopy. The calibration models based on NIR spectra of 144 samples were built for two different regression models, principal component analysis (PCR), and partial least square (PLSR) methods. Another 72 samples were used for external validation. The coefficient of determination (R^2) and root mean square error of calibration for validation and prediction were found to be 0.96–0.99, 0.44–0.91, respectively, for most of the results depending upon different pre-processing techniques and mathematical models used. The original reflectance spectra, the 1st derivative plot, the plot of PLSR regression coefficient (β), and the first three principal component loadings revealed metanil-related absorption regions. To verify the robustness of the models, the figures of merit (FOM) of the models were calculated with the help of net analyte signal (NAS) theory. Overall, it was found that PLSR yielded superior results as compared to the PCR technique. These methods can be applied to other spices also to detect the adulteration rapidly and without any prior sample preparations and with low cost.

Keywords NIR spectroscopy · Turmeric powder · Metanil yellow powder · Regression analysis · Figures of merit · Net analyte signal

Introduction

Spices have a far-reaching effect in our day to day lives, for example, they add flavor and color to our food and they give nourishment. Turmeric ($C_{21}H_{20}O_6$) is a member of ginger family and its major component is curcumin, a polyphenol. It has three chemical entities in its construction: two aromatic rings with phenolic groups, linked by a seven carbon linker. Turmeric is an important spice used in South and Southeast Asia extensively. It has widespread use in the medicinal industry due to its anti-inflammatory (Chainani 2003) and anti-oxidant (Kumar et al. 2006) property. But lately, for making commercial profit, this spice is adulterated with various harmful chemicals. Adulteration is an addition of a foreign material to particular food stuff in order to raise the quantity of the food item in an unprocessed form or processed form thereby hampering the genuine quality of that food stuff. This adulterant may be either a food item or a non-food item. Food adulteration may be of two types as suggested by Ayza and Belete (2015), namely incidental adulteration and planned adulteration. In incidental adulteration, additional components are included in a food substance due to carelessness or unawareness, for instance during harvesting. On the other hand, planned adulteration takes place for achieving economic gain. In the recent past, adulteration has become more complicated due to the use of unusual or artificial adulterants, resulting in related health risks. In the modern age, there is an increasing concern with regard to food fraud. Recently Peng et al. (2017) showed the existence of

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