Original Article

Near Infrared Spectroscopy As A Quick Tool To Identify Adulteration In Coariander (Coriandrum Sativum L.) Powder

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Abstract

Near Infrared (NIR) Spectroscopy is a rapid, non-destructive tool to analyse the food products qualitatively and quantitatively. In the present study NIR is used to analyse the adulteration of Coriander (Coriandrum sativum L.) powder. Coriander is considered an annual herb and spice since both its leaves and seeds are used as condiments. It is used in all of its components as a species (seeds, leaves and powder) and also used in cuisine as a flavouring agent. It is also known as Ayurveda medicine in the modern period. Saw dust was used as an adulterant. Nine samples were prepared by changing the concentration of the adulterant in the pure sample. Analysis was done using Principal Component Analysis in near infrared spectrum to classify the samples on the basis of quantity of adulteration. It was observed that NIR spectra were sufficient to identify the pure sample and the quantity of the adulterated sample using Principal Component Analysis. Satisfactory results were obtained which revealed that NIR spectra alone were sufficient for classification of adulterated samples.

Index Terms— adulteration, coriander powder, near infrared spectroscopy, principal component analysis.

INTRODUCTION

Near Infrared (NIR) spectroscopy uses spectral beams with wavelengths ranging from 750 to 2500 nm (13333–4000 cm-1), as no special reagent is used, and these technologies are not hazardous and are rapid for frequent measurements. Because of the shorter wavelength, the NIR technique produces more scattering and less absorption than conventional IR spectroscopies. NIR light, on the other hand, has a long penetration length and may pass through many skin coatings to reach the hypodermic region (Blanco & Villarroya, 2002, Khadem et al., 2020). Due to this feature it is used for quality and quantity analysis in different fields – agricultural, industrial, food and beverage industry, polymer industry and many more. This field is useful for analysis of food industry, spices.

Coriander is classified as an annual herb and spice since its leaves and seeds are both used as condiments. It is a member of the Umbelliferae family of carrots (Apiaceae). It's also known scientifically as Coriandrum sativum L. (Iqbal et al., 2019). As a spice, coriander is utilized in all of its components (seeds, leaves and powder). It is used as a flavoring agent in food and widely utilized species all throughout the world. In the current era, it is also known as auydevic medicine. Coriander offers several health benefits, including antioxidant activity, hypoglycemic activity, hyperlipidemic activity, insecticidal action, aflatoxin control, antibacterial activity, and antimutagenic potential. Digestive health and diarrhea management, mouth ulcers, anemia, small pox, menstrual problems, eye care, skin problems (Rajeshwari & Andallu, 2011). Due to its health benefits and multiple uses, it's prone to adulteration, which degrades its quality and essence. Main adulterants used to degrade the quality of coriander powder are cow dung, salt, ash, horse dung, powdered bran, saw dust. Other authors have studied the adulteration detection of coriander seeds with potential adulterants: salt and sawdust and starch. All samples were ground to a homogeneous powder prior to spectroscopic examination. NIR spectra were collected in range of 833-2500nm (12,000–4000 cm1) and analysis were performed using SIMCA 15 chemometric Software (Sartorius, Sweden) and TQ Analyst 8. (Thermo Fisher) using three different spectrometers - bench top, handheld and portable to check and compare their performances (McVey et al., 2021). Review by authors explains the role of spices and herbs in human life, adulteration of the commonly used spices and herbs, identification and detection of the adulterants using analytical, spectroscopic, chromatographic, electronic sensing, and

deoxyribonucleic acid-based methodologies (Osman et al., 2019). Another research was carried out to identify adulterants in chilli powder, turmeric and coriander powder using chemical methods which is destructive in nature. Various branded and non-branded samples were collected from Vellore. Analysis was done using chemical and visual methods. Adulterated products were identified, research was carried out to create awareness among the public. (Sen et al., 2017).

Literature reveals discuss various works which have been carried out to identify adulterants in spices using chemical, physical and visual methods. No or minimal research is reported where spectral data has been used to do the quality analysis by depicting the type and quantity of the adulterant. Present research focuses on identifying the quantity of the saw dust adulterant in coriander powder.

PROCEDURE FOR PAPER SUBMISSION

A. Sample Collection

Powdered samples were prepared in lab. Coriander seeds were purchased from local market. Seeds were cleaned for any external material and then grinded using a mini grinder. Saw dust was procured, cleaned and grinded. Samples were prepared by adding 5g, 10, 15, 20, 25, 30 and 50g of saw dust to coriander powder to make total sample as 100g. One pure coriander powder sample and saw dust sample were kept for analysis, resulting in all 9 samples. Mixed samples were again grinder to achieve homogeneous samples. To keep a same particle size, final adulterated samples were sieved through a fixed mesh size. Particle size affects the near infrared spectra thus there is need to obtain homogenous adulterated samples of similar grain size.

B. Spectra Acquisition

Samples were scanned using NIR DS 2500 spectrometer by Metrohm (@ CSIR-CSIO, Chandigarh) in the range of 400-2500 nm with a resolution of 0.5 nm. Instrument was operated in reflectance mode. Reflectance data was converted to absorbance data by the inbuilt VISION software with the instrument.

C. Statistical Analysis

Samples spectral data was analyzed using Principal Component Analysis (PCA) using CAMO Unscrambler X ver 10.5 at Department of Physics, Lovely Faculty of Technology and Sciences, Lovely professional University, Jalandhar and Clustvis open software. PCA was used to understand the data by reducing the complex data set. Nonlinear Iterative Partial Least Squares (NIPLAS) and singular value decomposition (SVD) were used by CAMO Unscrambler software and Clustvis software do develop and understand the relations between samples (scores) and variables (scores).

RESULTS AND DISCUSSION

In all 9 samples were there to check the saw dust adulteration. Table 1 shows the concentration of adulterant and pure coriander for the sample.

Table 1 Concentration of the prepared adulterated samples of 100g

Name of Sample	Amount of saw dust adulterant (in g)	Amount of coriander powder (in g)
C	0	100
D	100	0
D5	5	95
D10	10	90
D15	15	85
D20	20	80
D25	25	75
D30	30	70
D50	50	50

Spectral analysis

Vis-NIR spectra of the samples are shown in Fig1. It was observed that bands were observed around 450nm, 1220nm, 1500nm, 1750nm, 2000nm and above. It was observed that saw dust sample had lowest absorbance and the absorbance increases as the concentration of coriander is increased in the adulterant.

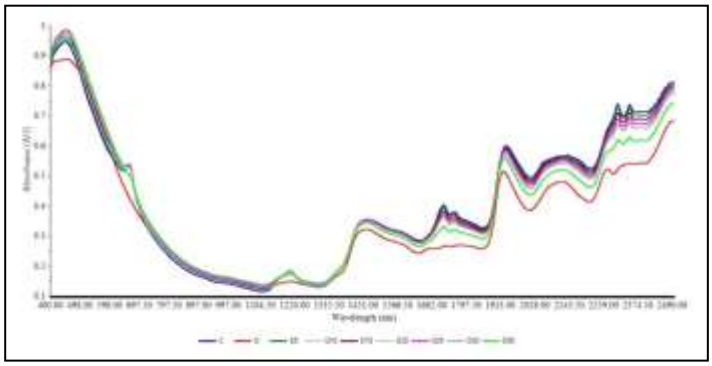

Figure 1 Vis-NIR spectra of the adulterated samples

Statistical analysis

Principal Component Analysis of the sample was performed on the spectral data. PCA helps in decreasing the complexity of the data. NIPLAS algorithm was used to generate Principal Components (PCs). Fig 2 shows the PCA of the samples, score plot for the data set. The classification of the samples is on the basis of the vis-NIR spectral data set. PC1 covers 89% of the complete data set and PC2 covers 11%. Both the PCs cover 100% data set.

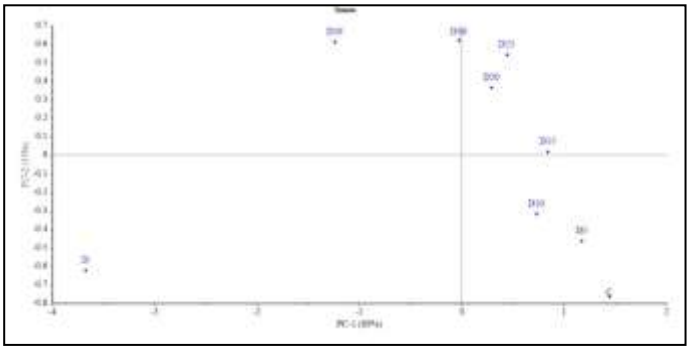

Figure 2 Principal Component analysis of the samples on the basis of spectral data – Score plot

It is clearly observable from the PCA that C (coriander) and D (saw dust) have different properties. Further it was observed that as the adulterant concentration is increased in the pure coriander powder, PC1 value decreases and PC2 value increases. Thus the samples with high adulteration are shifted from right bottom to left top of the PCA score plot.

PCA plot of the variables – loading plot is shown in Fig 3. Figure shows the correlations loadings of the variables – spectral data set for all the samples. The figure is divided into three parts on the basis of Y axis (correlation loadings). Wavelengths lying in the region of 0.7 to 1 and –0.7 to -1 are considered important for the adulteration of the sample. Wavelengths lying in the range of -0.6 to +0.6 are not important for the adulteration prediction. It was observed that 600-700nm, 1150-1250nm and 1400-2500 nm are more important for the adulteration detection of the samples.

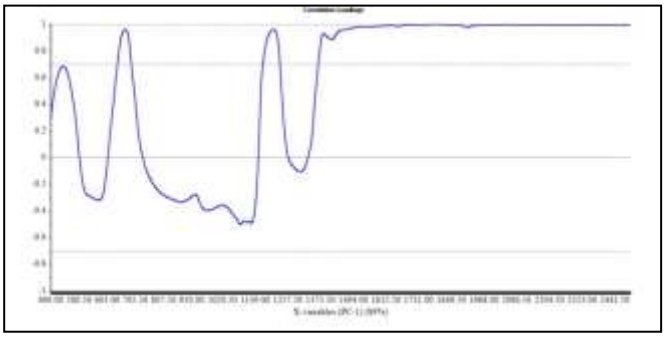

Figure 3 PCA of the samples for the wavelengths – correlation loading plot

CONCLUSION

Research work carried out on the 9 samples including coriander and the adulterant samples, shows that the NIR spectral data is useful in classification of the samples on the basis of PCA. It was clearly visible from the PCA that the samples are easily distinguishable. NIR spectroscopy is rapid, non destructive, non hazardous technique and does not require sample preparation, thus the samples adulteration can be tested without any distortion in the sample.

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