ScienceDirect

Microchemical Journal
Volume 208, January 2025, 112332

Detecting ferric oxide adulteration in chilli Powder: A Multimodal analytical approach for enhanced food safety

T. Vignesh [a], D. Selvakumar [b], R. Jayavel [c]

Show more

Share Cite

https://doi.org/10.1016/j.microc.2024.112332
Get rights and content

Highlights

- Adulteration of chilli powder with ferric oxide through chemical mixing.
- The impurities in the food materials are detected using sophisticated technology.
- The Conductivity increase by increasing adulteration content.
- The adulterants are distributed uniformly through the sample.

Abstract

Chilli powder, a widely used spice in global cuisine, faces rampant adulteration, posing significant health risks to consumers. One common adulterant is ferric oxide red, challenging to identify through visual inspection alone. To address this, a study was conducted to detect ferric oxide red in chili powder using various analytical techniques. Samples of chili powder, sourced from diverse locations, were adulterated with varying amounts of ferric oxide red. Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, and ultraviolet–visible spectroscopy (UV–Vis) were employed for analysis. FTIR spectra revealed characteristic peaks of chili powder at 1385 cm^{-1}, 1600 cm^{-1}, and 2935 cm^{-1}, alongside peaks indicative of ferric oxide red at 460 cm^{-1} and 540 cm^{-1}. Raman spectra displayed peaks at 260 cm^{-1}, 615 cm^{-1}, and 1315 cm^{-1} for chili powder and at 225 cm^{-1}, 306 cm^{-1}, and 670 cm^{-1} for ferric oxide red. UV–Vis spectra exhibited an absorption band at 478 nm for ferric oxide red. Elemental mapping analysis further differentiated adulterated and unadulterated samples. Principal component analysis (PCA) and soft independent modelling of class analogy (SIMCA) effectively distinguished between them based on spectral data. These findings underscore the efficacy of the proposed analytical methods in detecting ferric oxide red adulteration in chilli powder, ensuring its safety and quality.

Graphical abstract

Download: Download high-res image (170KB)

Download: Download full-size image

Introduction

Food powders are widely available to consumers, but their susceptibility to intentional adulteration with chemicals or additives poses a significant threat to food safety. Adulteration, primarily driven by commercial interests, can occasionally also be malevolent or pose risks to public security. Adulteration of food powders with various substances such as starch, curry powder, wheat gluten, and turmeric has been documented [1], [2]. Food quality is one of the most important in our life. The quality of food is deceased nowadays due to the cost and mixture of the adulterant to the powder material. The colour agent added to the food material is hazardous to the health and human life. Many of the shop owner added the colour agent adulterants to the food material for their benefits. The colour agent adulterant like Sudan dye, dyes, brilliant blue, Tartrazine, etc [3]. Chili is grown all over the world and is commonly used as spices and condiments in a variety of traditional and continental dishes. India is currently the world's largest producer of dried chili peppers (1.74 million tons, or 46.3% of total production), and Nigeria, Egypt, and Ghana are regular producers of dried chili peppers that are sold internationally [4]. The spread of chili peppers over the world has led to weaknesses that allow for food fraud. The majority of chemicals added to powdered chili pepper in order to deceive consumers share structural similarities with the powdered chili pepper, which makes detection challenging [5]. Several frequent adulterants used in the adulteration of chili pepper powder are brick, sawdust, maize bran, artificial colouring, and para red dye, which is a member of the Sudan dye family (Sudan I, II, III, and IV), powder, cola nuts, pear seeds, cassava flour, and other ingredients used in the production of chili powder EMA [6], [7]. The most common ones, according to Essuman et al., are cola nuts, pear seeds, and artificial colouring [7]. Identifying and detecting these adulterants isn't always straightforward. Nonetheless, various analytical methods have been employed to predict and detect them in chilli. These techniques include polymerase