

Measurement of Counterfeit Pharmaceuticals

Using the Spectrum Spotlight 350



Introduction

Counterfeiting of pharmaceuticals and the proliferation of substandard drugs constitute a serious health risk for the world population, including both industrialized and developing countries.

The sale and distribution of counterfeit drugs leads to failed treatment, disability, and even death; their manufacture, distribution and sale are serious crimes.

Loss of revenue for the pharmaceutical industry and potential exposure to huge damage claims will push up

the price of legitimate pharmaceutical products.

The WHO defines counterfeit drugs as 'deliberately and fraudulently mislabelled with respect to identity and/or source' and that 'Counterfeiting can apply to both branded and generic products and...may include products with correct ingredients, with wrong ingredients, without active ingredients, with insufficient quantity of active ingredient or with fake packaging.'¹

The Scale of the Problem

Current it is estimated that 5-8% of the world's total pharmaceutical sales are counterfeit or of dubious quality. This is an average figure: pharmaceutical counterfeiting varies hugely from country to country.

Technologies

Of the several types of counterfeiting defined by the WHO, this application covers the case where the counterfeit is chemically very similar to the genuine product, containing active ingredient and excipients in the correct concentrations. Traditional

techniques such as HPLC and NIR spectroscopy could not differentiate the genuine and counterfeit products: they both work at the macro level, so would show only that the concentrations of ingredients were very similar.

In many cases, counterfeit products use stolen or illicitly obtained packaging materials, so again detection of the counterfeit product could not be based on identification of fake packaging.

This type of counterfeiting, where the counterfeit has identical packaging and chemically very similar or identical chemical composition, is clearly difficult to differentiate with traditional macro techniques.

This application therefore discusses the identification of counterfeit drugs based on differences in the distribution of ingredients within the product. This may be caused by different blending processes, or differences in the ingredients, which could be in fine powder, fine crystalline or coarse crystalline form.

Distribution of ingredients in a powder determined using the Spectrum Spotlight 350 FT-NIR imaging system is compared with reflectance analysis using a conventional non-imaging FT-NIR spectrometer.

Method

Samples were a proprietary analgesic capsule containing

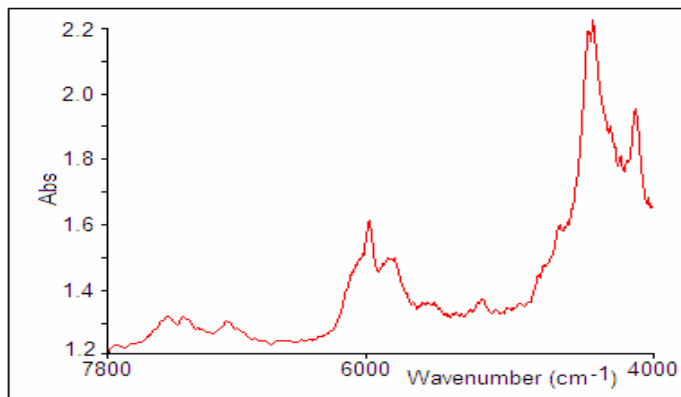
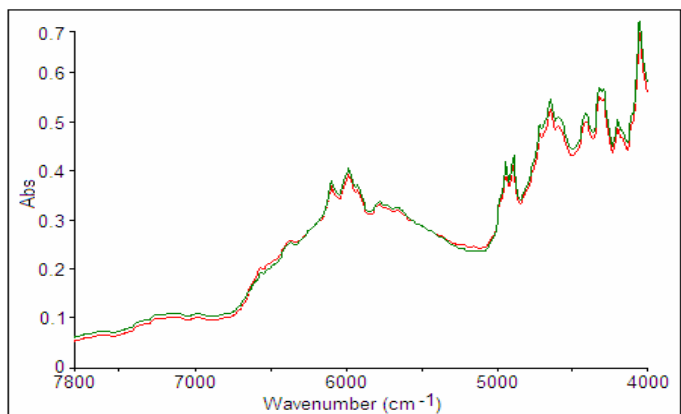


Figure 2. Genuine (green) and Counterfeit (red) Products measured using the NIRA System – **Macro Sampling**



5% w/w caffeine, and a second analgesic capsule with no caffeine. The latter was adulterated with 5% caffeine, representing a counterfeit copy.

The capsules were opened and the contents poured (overfilled) into a stainless steel cup. The top was leveled to ensure that the sample surface was regular and flat.

Imaging Method

Spectra were collected on the Spotlight 350 between 7800 and 4000 cm^{-1} , using 16 cm^{-1} spectral resolution, 25 μm pixel resolution, 2 scans per pixel. Image size

was approximately 800 x 1200 μm , image acquisition took less than two minutes.

NIRA Method

Spectra were recorded using the Spectrum One NTS FTIR Spectrometer with Tablet Autosampler. Spectra were recorded in reflectance mode between 7800 and 4000 cm^{-1} with 16 cm^{-1} spectral resolution, 1 minute per scan.

Results

The caffeine reference spectrum, collected using the Spectrum Spotlight 350, is shown in Figure 1.

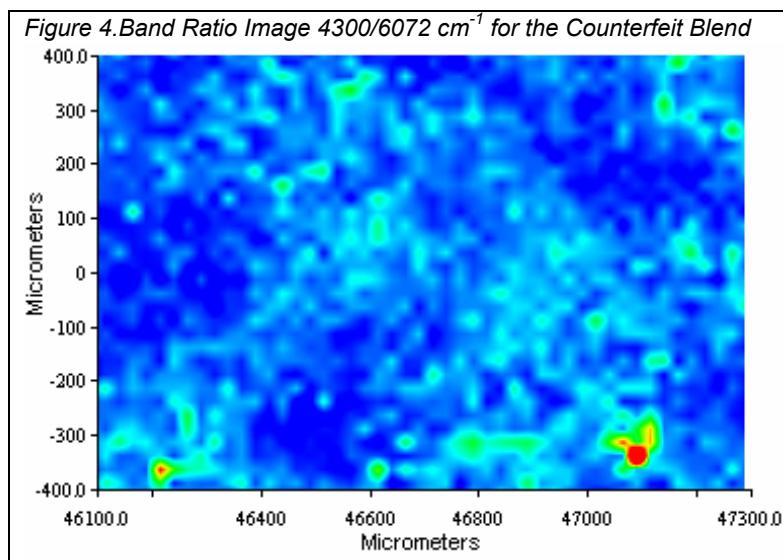
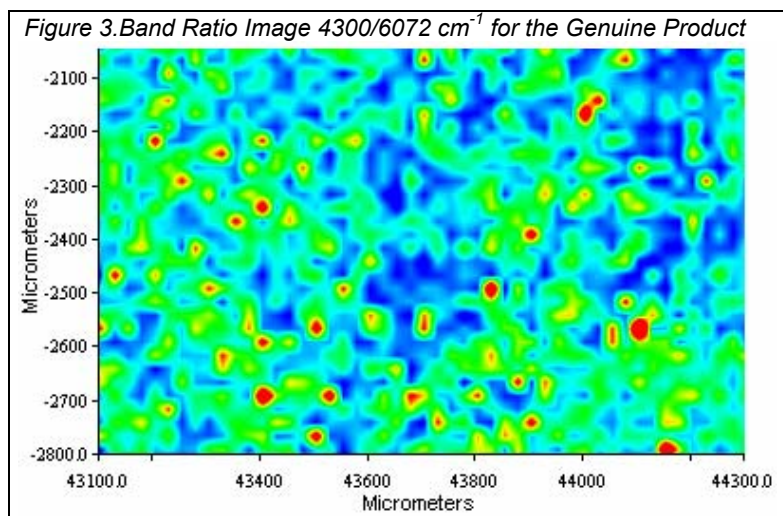
Figure 2 shows the NIRA absorbance spectra for the genuine and counterfeited blend. Differences between the two spectra were minimal, and could be due to differences in excipients: the concentrations of many of these were not stated for either product.

Figures 3 and 4 show the Band Ratio images for the genuine and counterfeited products respectively.

The distribution of caffeine is clearly homogeneous in the genuine product, but very localized in the counterfeit, reflecting different manufacturing processes. Note that both images are ratios, and are auto-expanded in terms of the ratio axis. The absorbance ratio in the counterfeit sample image is much higher than in the genuine sample image: the absolute amount of caffeine in each sample is the same.

Conclusions

The Spectrum Spotlight 350 FT-NIR imaging system is ideally suited to the rapid identification of counterfeit drugs based on the distribution of ingredients. Traditional techniques could not perform this task as they report only the overall chemical composition of the sample.



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