Introduction

Coptidis Rhizoma (the root of the *Coptis chinensis* plant), which is also known as goldthread, is one of the most commonly used traditional Chinese medicines (TCM). It can clear heat and reduce fire and is usually used for diarrhoea, vomiting, jaundice, fever, toothache, conjunctivitis, and some other conditions.¹

In the Chinese Pharmacopoeia, the isoquinoline alkaloid berberine is considered as the marker component of Coptidis Rhizoma and is used for the identification of this herb.¹ However, berberine is also present in some other herbs, such as Phellodendri Chinensis Cortex and Phellodendri Amurensis Cortex, which are used to treat different conditions.²,³

In general, the strategy of relying on a single marker compound to identify a herb is clearly not reliable, as there may be other herbs containing the same compound. Robust identification requires consideration of the entire chemical composition of the sample. Among analytical methods that can provide this information, infrared spectroscopy offers a unique combination of specificity, sensitivity, speed, and convenience of sampling. In recent years, numerous academic papers have been published describing the use of infrared spectroscopy for characterisation of herbal medicines.⁴-⁶ Practical guidelines for successful implementation of the method have recently been published.⁷
In this note, we show that Fourier Transform Infrared Spectroscopy (FT-IR) can be used to identify the existence of berberine in Coptidis Rhizoma samples and to distinguish Coptidis Rhizoma from Phellodendri Chinensis Cortex and Phellodendri Amurensis Cortex.

**Experimental**

Berberine hydrochloride was purchased from Sigma-Aldrich®. Samples of raw Coptidis Rhizoma, Phellodendri Chinensis Cortex, and Phellodendri Amurensis Cortex were obtained from the Institute of Chinese Materia Medica of the China Academy of Chinese Medical Sciences.

Spectra of berberine hydrochloride, Coptidis Rhizoma, and the Phellodendri Chinensis Cortex and Phellodendri Amurensis Cortex samples were measured on a PerkinElmer® Spectrum™ 100 FT-IR spectrometer equipped with a single-bounce diamond attenuated total reflectance (ATR) sampling accessory (Figure 1). Spectra were acquired at 4 cm⁻¹ resolution and for an accumulation time of 60 seconds. The spectra were analyzed in Spectrum software (version 10).

**Results and Discussion**

**Confirmation of the presence of the marker compound**

Comparing the FT-IR spectra of berberine hydrochloride and the raw Coptidis Rhizoma (Figure 2), we can see that all of the major absorption peaks of berberine, including those at 1507, 1385, 1362, 1340, 1271, and 1232 cm⁻¹, are also present in the spectrum of Coptidis Rhizoma. This gives us confidence that the marker compound is indeed present in the sample.

Berberine is just one component of the herb and so its peaks are overlapped with peaks from other compounds. Taking the second derivative of the IR spectra can help to identify peak locations in the presence of overlapping peaks. Using this approach (as shown in Figure 3) gives a clearer match between the locations of the berberine peaks and those of the Coptidis Rhizoma sample.

**Discrimination of Coptidis Rhizoma from some other similar herbs**

Figure 4 shows the FT-IR spectra of Coptidis Rhizoma and the bark of two other berberine-containing herbs, Phellodendri Chinensis Cortex and Phellodendri Amurensis Cortex. These are quite similar materials, and peaks due to berberine and other compounds commonly found in plants are visible in all three spectra. However, there are some clear differences among the spectra. All three materials have a peak at around 1730 cm⁻¹, but this peak is very weak in the Coptidis Rhizoma spectrum and markedly stronger in the cortex Phellodendri spectra. The broad band at around 1600 cm⁻¹ peaks at 1629 cm⁻¹ for Coptidis Rhizoma, but at about 1604 cm⁻¹ for the other two herbs. Finally, Coptidis Rhizoma lacks the peak at about 1420 cm⁻¹ that is present for the cortex Phellodendri samples. It is easy to discriminate Coptidis Rhizoma from Phellodendri Chinensis Cortex and Phellodendri Amurensis Cortex even though they all contain berberine. Note, however, that a distinction between the two Phellodendri species would not be possible by this simple inspection approach.

![Figure 1. The Frontier FT-IR.*](image)

![Figure 2. FT-IR spectra of berberine hydrochloride and the raw Coptidis Rhizoma.](image)

![Figure 3. Second derivative IR spectra of berberine hydrochloride and the raw Coptidis Rhizoma.](image)

![Figure 4. FT-IR spectra of Coptidis Rhizoma and the bark of two other berberine-containing herbs.](image)
Conclusions

FT-IR can be a simple and powerful method for quality control of TCM. In contrast to methods relying on a single marker compound, FT-IR allows discrimination among similar herbs – such as the three berberine-containing herbs considered here. ATR accessories (particularly diamond ATR as used here) provide a very quick and simple way to measure the spectra of sufficiently homogeneous TCM samples.

*The Frontier FT-IR supersedes the Spectrum 100.

References


Figure 4. FT-IR spectra of the raw Coptidis Rhizoma, Phellodendri Chinensis Cortex, and Phellodendri Amurensis Cortex.