

# Counterfeit cigars: can near infrared detect them?

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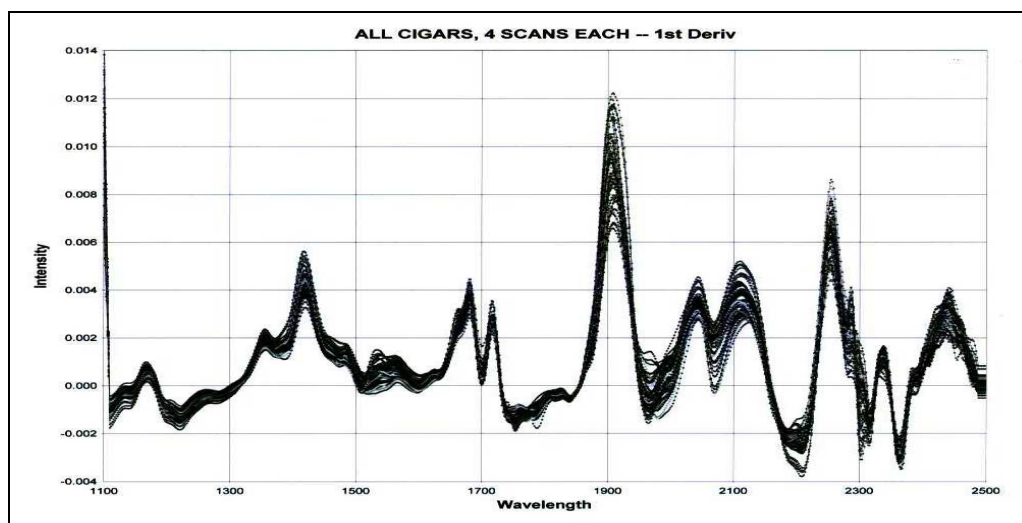
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## Introduction

More than 3,000,000 counterfeit cigars are sold in the United States every year. These fakes are said to be “Cuban” but they aren’t. This preliminary study addresses the feasibility of near infrared (NIR) spectroscopy for identifying the fakes.

## Experimental

Following a query on the Internet, 14 samples were provided by a curious and concerned dealer in tobacco products: seven each Cuban and non-Cuban cigars. All but one came with its identifying band. They were scanned over the range 400–2500 nm on a Foss/NIRSystems Model 6500 spectrometer. Samples were positioned on a remote reflectance attachment over a white Teflon mask to limit the scanned area to a  $2 \times 1/2$ ” rectangle. A minimum of four scans of each cigar was made by rotating the sample around its long axis in  $90^\circ$  increments. No obvious differences could be seen between the two groups, particularly below 1100 nm, so the first derivatives were computed as shown in Figure 1.



**Figure 1. 1st derivatives of Cuban and non-Cuban cigars.**

The vendor’s IQ<sup>2</sup> software revealed encouraging discrimination when used in the MATCH BY DISTANCE mode. Although two data points were  $>3\sigma$ , all IDs were correct (Table I).

Table 1. NIRSystems Inc. library validation report.

Library:	CIGARS		
Number of Products :	2		
Instrument :	6500	Math Treatment:	2nd Deriv
Scan Range :	400 - 2500		
Selected :	1100 - 2466		
Identify Correlation Threshold :	0.85		
Identify Distance Threshold :	6.00 $\sigma$		
<u>Match by Correlation</u>		<u>Match by Distance</u>	
Correct ID		I	
Y 41		Y N	
N 17		II Y 56 0 56	
58		N 2 0 2	
		58 0 58	
		Type I : Sample ID Correct	
		Type II : Distance < 3.00 $\sigma$	

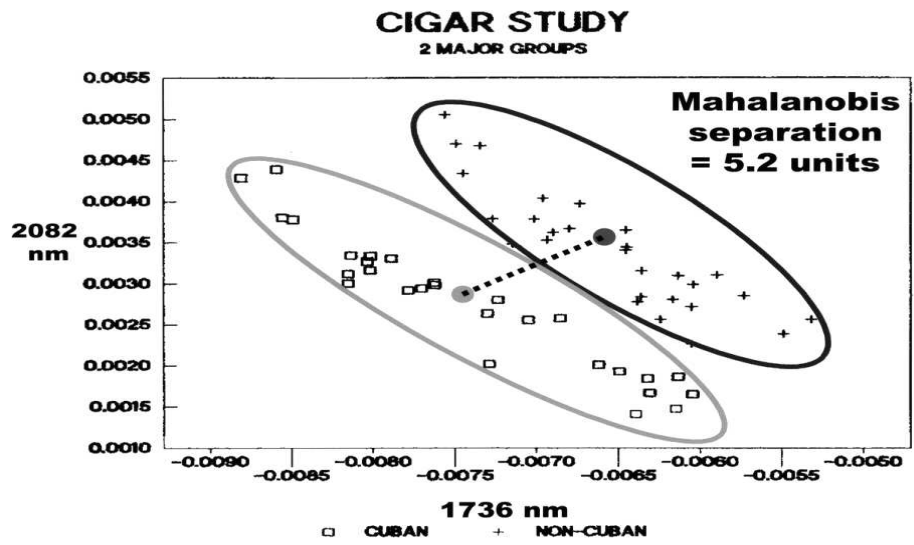


Figure 2. Cluster diagram of two major groups.

Absorbances at the two best wavelengths were used to show the Mahalanobis separation (5.2 units) in a discriminant plot (Figure 2). All but one of the non-Cuban cigars were reasonably well separated from the Cuban group when plotted with only two wavelengths (Figure 3).

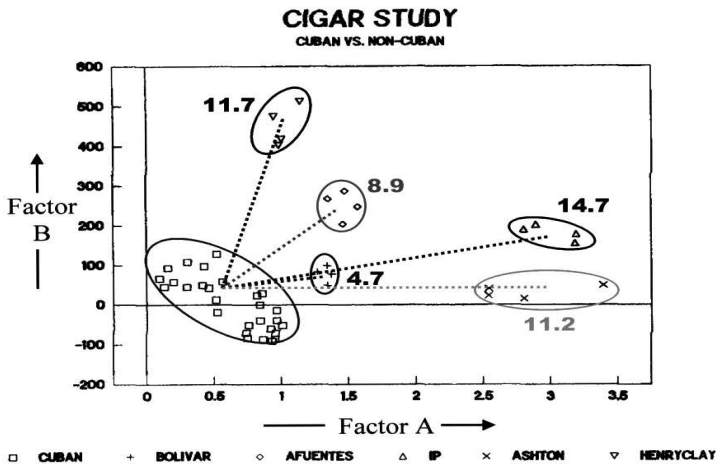


Figure 3. Cluster Diagram - Cuban group vs. 5 non-Cubans

Another discriminant analysis program from a 3rd party vendor (Mark Electronics)<sup>1</sup> identified three wavelengths that produced even better separation when plotted as 3-D clusters (Figure 4). This suggests that three wavelengths may be necessary and sufficient.

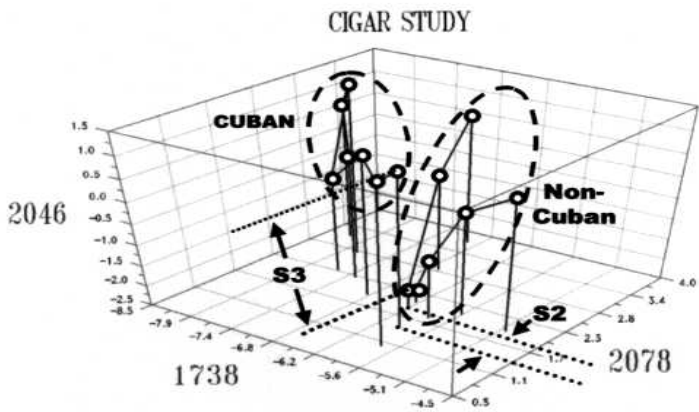


Figure 4. Three-dimensional cluster diagram; S3 = separation in 3 dimensions; S3 = separation in 2 dimensions.

One cigar was sacrificed (peeled apart) to determine the depth to which the near infrared beam penetrated, i.e. how many layers (leaves) of tobacco were contributing to the spectrum of the cigar. This could be estimated by observing the step-wise decreasing structure of the spectrum of a sheet of polyethylene plastic (Figure 5). Since the NIR beam descends through at least three layers, it seems unlikely that a counterfeiter could wrap a fake cigar with a single layer of Cuban tobacco and pass it off as a Cuban cigar.

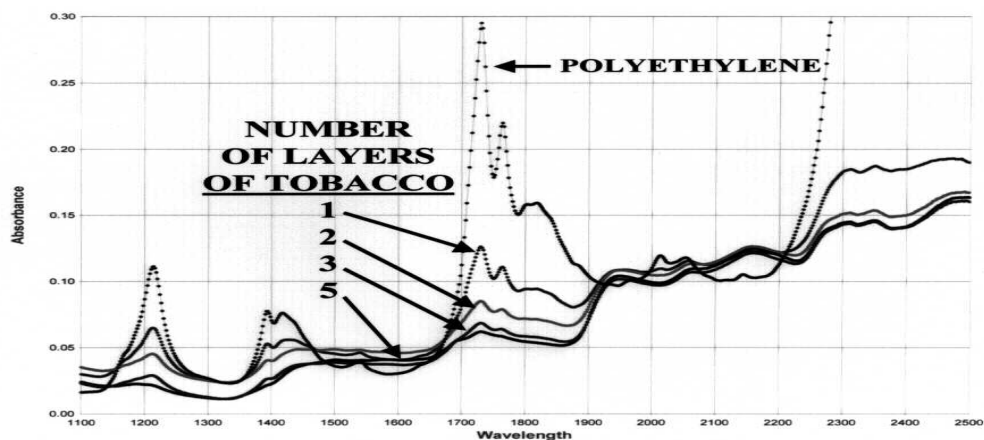


Figure 5. Penetration study.

When the “key” (identification) for the test samples was provided, none of them turned out to be among those that were used in the discriminant program. The identity of all 28 samples is given in Table 2.

## Conclusions

Although this preliminary study strongly suggests that NIR can be a route to the detection of counterfeit cigars, it's apparent that a larger data set must be incorporated. A major difficulty with any study of counterfeit/fraudulent materials is finding a valid source of samples; those who possess such samples are usually reluctant to admit they are fakes. Equally important is knowing for certain that genuine samples are as labelled.

## Additional reading

There are a number of websites that deal with counterfeit cigars.<sup>2-7</sup> Most of them are essentially an offer to sell to subscribers, while some may address such items as the tax seal/stamp and various ways of packaging the cigars. None appears to deal with a scientific method of identification. Here, we take the first step with a spectrophotometric approach.

