Counterfeit cigars: can near infrared detect them?

D.A. Burns

NIR Resources, 2 La Flora Court, Los Alamos, NM 87544, USA

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 $2\times1/2$ " rectangle. A minimum of four scans of each cigar was made by rotating the sample around its long axis in 90° 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.

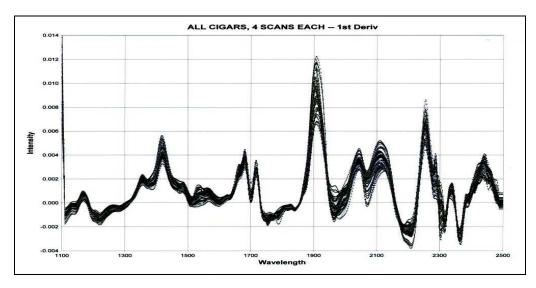


Figure 1. 1st derivatives of Cuban and non-Cuban cigars.

The vendor's IQ^2 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).

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Table 1. NIRSystems Inc. library validation report.

Library: CIGARS
Number of Products: 2

Humber of Froducts. 2

Instrument: 6500 Math Treatment: 2nd Deriv

Scan Range : 400 - 2500 Selected : 1100 - 2466

ch by Correlation	Match by Distance			
orrect ID			I	
41		Y	N	
17	II Y	56	0	56
58	N	2	0	2
	58	0	58	
	17	orrect ID 41 17 II Y 58 N	orrect ID 41 Y 17 II Y 56 58 N 2	orrect ID I Y N 17 II Y 56 0 58 N 2 0

Type I : Sample ID Correct Type II : Distance \leq 3.00 σ

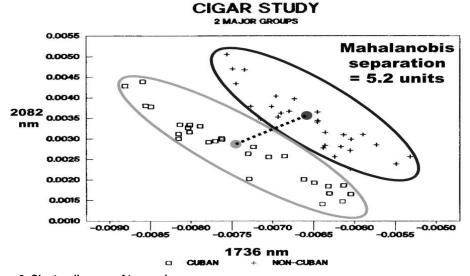


Figure 2. Cluster diagram of two major groups.

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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).

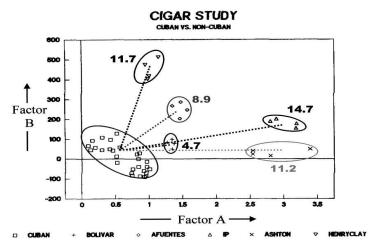


Figure 3. Cluster Diagram - Cuban group vs. 5 non-Cubans

Another discriminant analysis program from a 3rd party vendor (Mark Electronics)¹ 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.

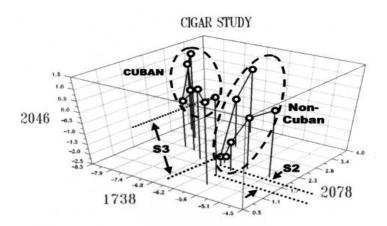


Figure 4. Three-dimensional cluster diagram; S3 = separation in 3 dimensions; S3 = separation in 2 dimensions.

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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.

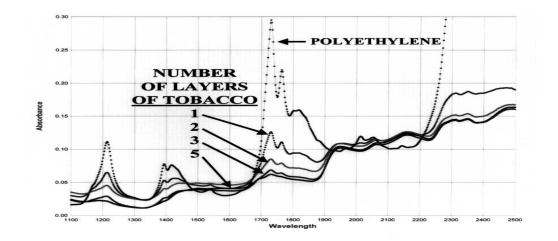


Figure 5. Penetration study.

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. ²⁻⁷ 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.

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Table 2. Identification of all cigars: top 14 are standards; unknowns are lettered.

Table 2. Identi	neation of all eigars; top 14 a			are lettereu.		
	<u>CUBAN</u>	NON-CUBAN	<u> </u>			
	Cohiba	Cifuentes				
	Unlab-short	Punch				
	St Luis	Bolivar				
	Bolivar	Afuentes				
	Monte	IP				
	Unlab-long	Ashton				
	Diplomat	Henry Clay				
		<u>C</u>	<u>N</u>	Origin		
A	Habana Diplomatico #5	X	_			
В	Habana Hoyo Epicure #1	X				
C	Padron Cafeteria		X	Nic		
D	Habana SLR Serie A	X				
E	Trinidad Corona		X	Afr DR		
F	FDA Maximo		X	Edu Hon DR		
G	Vegas de Fonseca Church	ill	X	Afr DR		
Н	Habana Cohiba Siglo 4	X				
J	Aristoff Perfecto		X	Ecu Hic DR		
K	Moore & Bode Corona		X	USA		
L	Habana Hoyo #2	X				
M	H Upmann Extra Finos		X	Ind Dr		
N	Habana Montecristo Rob	usto x				
P	Bolivar Fuerte Cuban Co	rona	X	Ecu Hon Nic		
	KEY: C = Cuban N =	= Non-Cuban	Afr = Af	frican DR = Domican		
Republic						
Ecu = Ecuador Hon = Honduras Ind = India Nic =						
Nicaragua						
_	USA = United St	ates				

References

- 1. Mark Electronics, 21 Terrace Ave, Suffern, NY 10901, USA.
- 2. "The Ultimate Counterfeit Cuban Cigar Primer,"

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- 6. "Franklin Liquors Cigar Page/Cuban Counterfeit Lab,"

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7. "Counterfeit Gallery," cigaraficionado.com/Cigar/Aficionado/Counterfeit/countgal.html